mercruiser

SERVICE MANUAL

INDEX

Number 10

MARINE ENGINES

GM 4 Cylinder

Printed in U.S.A.

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90-14693--1 1-194

Models Covered in This Manual

MODEL	SERIAL NUMBER
MCM 120 MR	6853914-0A492055
MCM 120 Alpha I	0A492056-0B531853
MCM 2.5L	0C856450 and Above
MCM 140 MR	6852270-0A484072
MCM 140 Alpha I	0A484073-0B450800
MCM 3.0L	0C856450 and Above
Sea Ray 3.0L	0B787205-B917530

NOTICE

MCM 2.5L - Same as MCM 120.
MCM 3.0L
Sea Ray 3.0L - Same as MCM 140 (Later Models are rated at 130 HP and have 9.2:1 Compression ratio.)

IMPORTANT: Refer to engine identification, page.

NOTICE

Refer to Appropriate Stern Drive service manual for transom assembly and Stern Drive unit repair.

Notice

Throughout this publication, "Dangers," "Warnings" and "Cautions" are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. —— Observe them carefully!

These "Safety Alerts" alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus "common sense" operation, are major accident prevention measures.

⚠DANGER

DANGER — Immediate hazards which WILL result in severe personal injury or death.

⚠WARNING

WARNING — Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠CAUTION

CAUTION — Hazards or unsafe practices which could result in minor personal injury of product or property damage.

Notice To Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers, mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

Replacement Parts

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durabilty, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

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IMPORTANT INFORMATION

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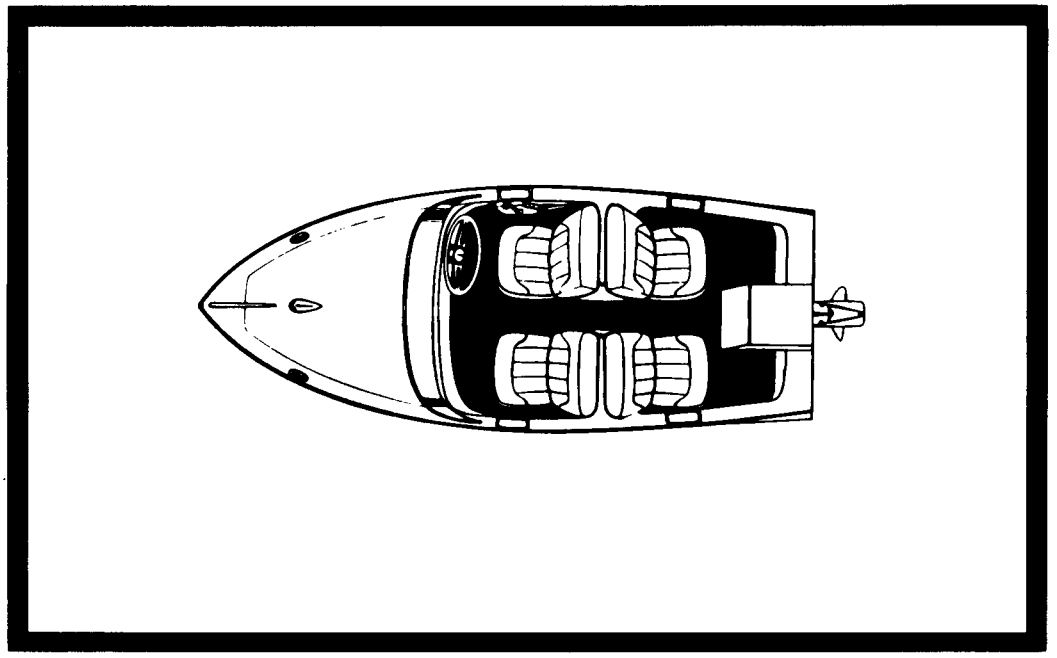
A



mercruiser
STERN DRIVES & INBOARDS

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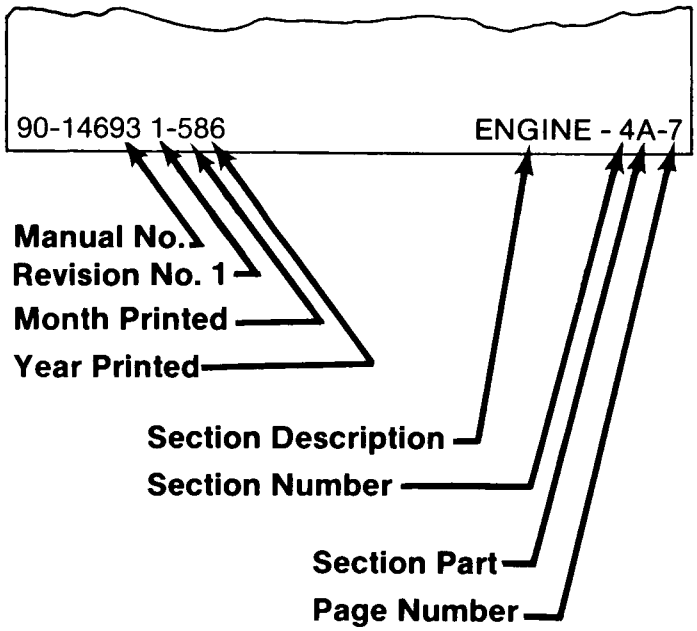
How to Use This Manual

This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

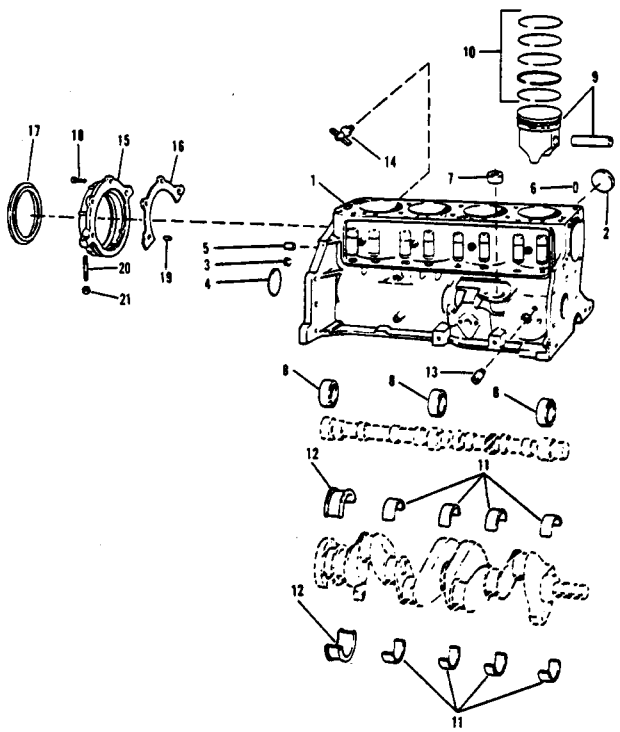
Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



How to Read Parts Manual

CYLINDER BLOCK, PISTON and BEARINGS



PART NO.	REF. NO.	DESCRIPTION	QUAN.
839- 810839	1	CYLINDER BLOCK ASSEMBLY	1
19- 34270	2	EXPANSION PLUG (1-5/8" DIA.)	2
19- 34271	2	EXPANSION PLUG (2" DIA.)	1
19- 37531	3	PLUG	1
19- 34488	4	EXPANSION PLUG	1
19- 34487	5	PIPE PLUG (3/8")	2
17- 35465	6	DOWEL PIN	2
23- 35168	7	BEARING	1
23- 43293	8	BEARING UNIT	1
733- 810852	9	PISTON/PIN (STD.)	4
733- 810853	9	PISTON/PIN (.020 O.S..)	AR
39- 17464	10	PISTON RING UNIT (STD.)	4
39- 17465	10	PISTON RING UNIT (.020 O.S.)	AR
23- 818469	11	BEARING UNIT (STANDARD)	4
23- 85676	11	BEARING UNIT (.001 U.S.)	AR
23- 85713	11	BEARING UNIT (.010 U.S.)	AR
23- 85714	11	BEARING UNIT (.020 U.S.)	AR
23- 85715	12	BEARING UNIT (REAR - STANDARD)	1
23- 85670	12	BEARING UNIT (REAR - .001 U.S.)	AR
23- 85718	12	BEARING UNIT (REAR - .010 U.S.)	AR
23- 85719	12	BEARING UNIT (REAR - .020 U.S.)	AR
34543	13	VALVE	1
22- 16951A1	14	DRAIN FITTING	1
14239	15	RETAINER (REAR)	1
#27- 14241	16	GASKET	1
#26- 14240	17	OIL SEAL (REAR)	1
10- 810844	18	BOLT	2
17- 14263	19	DOWEL PIN	1
16- 11989	20	STUD	2
11- 810847	21	NUT, oil pan stud	2

839-810839 Cylinder Block Assembly includes only standard pistons, piston rings, crankshaft bearings and camshaft bearings.

PARTIAL ENGINE
(Includes Internal Parts and Cylinder Heads)
815509A1 (3.0L)
815510A1 (3.0LX)

GASKET SETS AND SEALANTS - required for complete overhaul
= 27-810846A90 GASKET SET, engine overhaul
92-91601--1 SEALER, red RTV (where applicable)
92-34227--1 PERFECT SEAL (where applicable)

A. **Part Number:** part must be ordered by complete part number.

B. **Reference Number:** number of part on exploded parts view.

C. **Description:** this column provides important information.

(1) Description of part: Reference 1, on the parts list, is a CYLINDER BLOCK ASSEMBLY; reference 14 is drain fitting.

(2) What parts are included: Reference 1, on the parts, is "CYLINDER BLOCK ASSEMBLY." Parts listed under the assembly are indented, which indicates that they are included. So, if Part No. 839-810839 is ordered, you will receive the Cylinder Block Assembly, including all of the parts listed below down to reference 14 DRAIN FITTING.

(3) Serial number break: If serial number is listed, check product serial number to ensure that correct part is ordered.

(4) Special Information: Will often appear after the description, i.e.: "NUT, oil pan stud." This information enables you to select correct parts.

D. **Quantity:** specifies quantity which must be ordered.

E. **Special Information Block:** provides additional information, part numbers for gasket sets, etc.

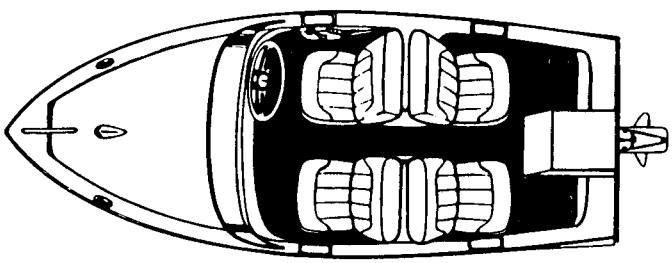
Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the MerCruiser models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment, to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

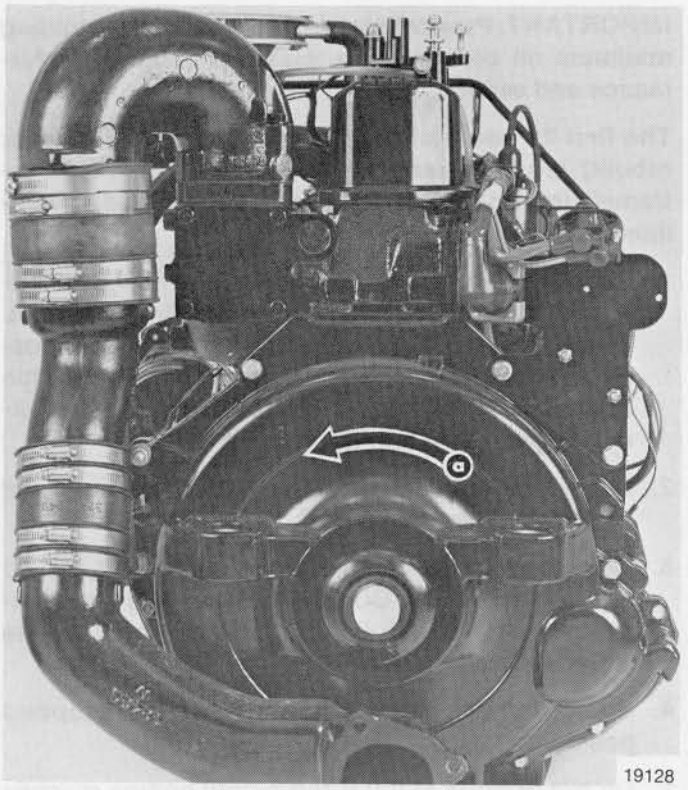
Directional References

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern, looking toward bow.



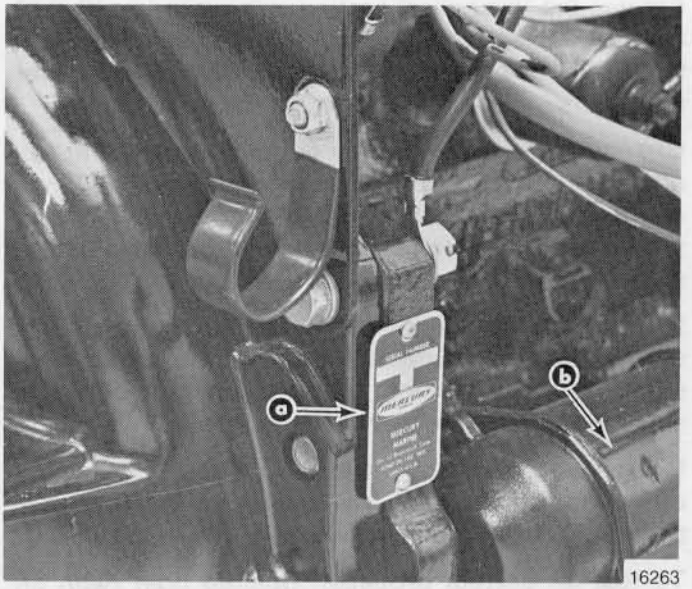
Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern drive end) of the engine looking forward (water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



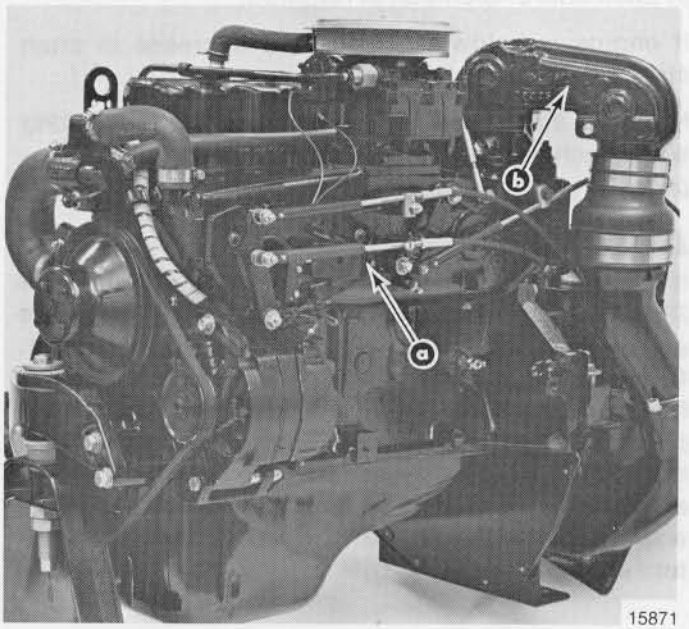
a - Standard Left-Hand Rotation

Serial Number Location



a - Serial Number Plate
b - Starter Motor

Engine Identification



a - Shift Plate On Side of Exhaust Manifold
b - Off-Set Exhaust Elbow

Propeller Information

Refer to the "Propeller" section in "MerCruiser IR-IMR Service Manual" 90-12934 or order publication P/N 90-86144 "What You Should Know About Quicksilver Propellers . . . and Boat Performance Information".

Changing diameter, pitch or coupling a propeller will affect engine RPM and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller, to allow the boat motor to operate within its specified RPM range at wide open throttle (W.O.T).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that under heavy load engine speed will not fall below specifications.

If engine exceeds the recommended RPM, an increase in pitch and/or diameter is required.

If engine is below rated RPM, a decrease in pitch and/or diameter is required.

Normally a change of approximately 300 to 500 RPM will be achieved for each single pitch change of propeller.

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Hi-Performance Boating

Written by Marine Engineers, order publication P/N 90-86168, entitled "Hi-Performance Boat Operation".

Engine 20-Hour Break-In Period

IMPORTANT: Proper break-in is essential to obtaining minimum oil consumption, maximum engine performance and service.

The first 20 hours of operation is the engine (new or rebuilt) break-in period. During this period, it is extremely important that the engine is operated, as outlined following.

1. Do not operate engine below 1500 RPM for extended periods of time during the first 10 hours. During this period, shift into gear as soon as possible after starting engine and advance throttle so that RPM is above 1500 (provided that conditions permit safe operation at this speed).
2. Do not operate at any one constant speed for extended periods of time.
3. Do not exceed 3/4 of full throttle during the first 10 hours of operation. During the next 10 hours, occasional operation at full throttle (5 minutes at-a-time maximum) is permissible.
4. Avoid full throttle acceleration from stopped position.
5. Do not operate at full throttle until engine reaches normal operating temperature.
6. Observe instrumentation carefully. If an abnormal reading occurs, stop engine immediately and determine cause.
7. Frequently check crankcase oil level and add oil, if necessary. It is normal for oil consumption to be somewhat high during the break-in period.
8. At end of 20-hour break-in period, drain break-in oil from crankcase and replace oil filter. Fill crankcase with correct grade and viscosity oil.

20-Hour Checkup

After first 20 hours of operation, an Authorized MerCruiser Dealer should be contacted for the following maintenance. The boat owner is responsible for any charges.

- Change crankcase oil and filter.
- Check all fluid levels.
- Cooling System - Inspect all hoses for damage and deterioration; check all hose clamps for adequate tightness.

- Check carburetor adjustment.
- Inspect ignition system and timing.
- Check for loose, missing or damaged parts.
- Check shift and throttle cable adjustments - lubricate and inspect for loose, damaged or missing parts.
- Steering System - Lubricate and inspect for loose, damaged or missing parts.
- Inspect all drive belts.
- Check engine alignment.
- Complete Engine Exhaust System Inspection - Inspect for damage and deterioration; check all hose clamps for adequate tightness.
- Retorque gimbal ring clamping U-bolt to 40 lb. ft. (54 N·m).

Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruisers, or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

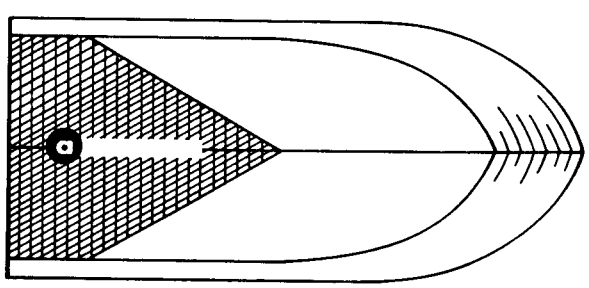
1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

IMPORTANT: Do not run at maximum RPM for more than 2 minutes.

Boat and Engine Performance

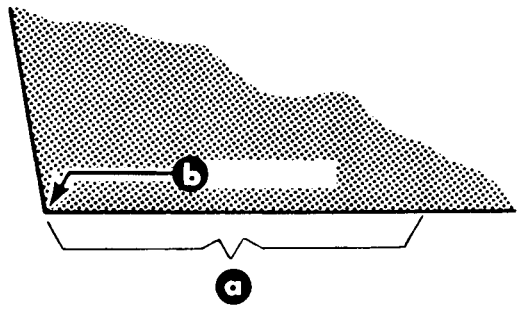
Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5m).



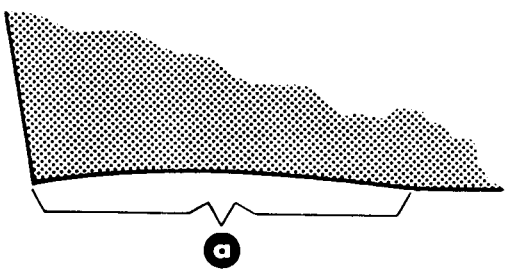
a - Critical Bottom Area

For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



a - Flat
b - Sharp Corner

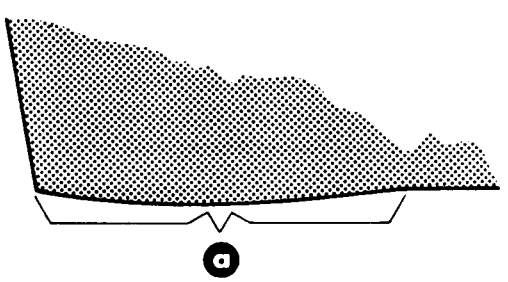
The bottom is referred to as having a "hook" if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed, but it helps planing and reduces any porpoising (rythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook can also be caused by not trailering or storing the boat with support directly under the transom.



a - Hook

A "rocker" is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles-per-hour on a fast boat.



a - Rocker

Marine Fouling

Fouling is an unwanted buildup (usually animal-vegetable-derived) occuring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. So it's important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as anti-fouling paint, will reduce the rate of bottom fouling. However, due to the fact that drive units (outboard or stern drive) are made primarily of aluminum, be sure to select an anti-fouling paint having a copper-free, organo-tin base. The BIS (Tri Butyl Tin) Adipate (TBTA) base paint will not set up a galvanic corrosion "cell" as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instruction, it is also very effective.

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight — cargo and passengers — should be as far aft as possible to allow the bow to come up to a more efficient angle (3° to 5°). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

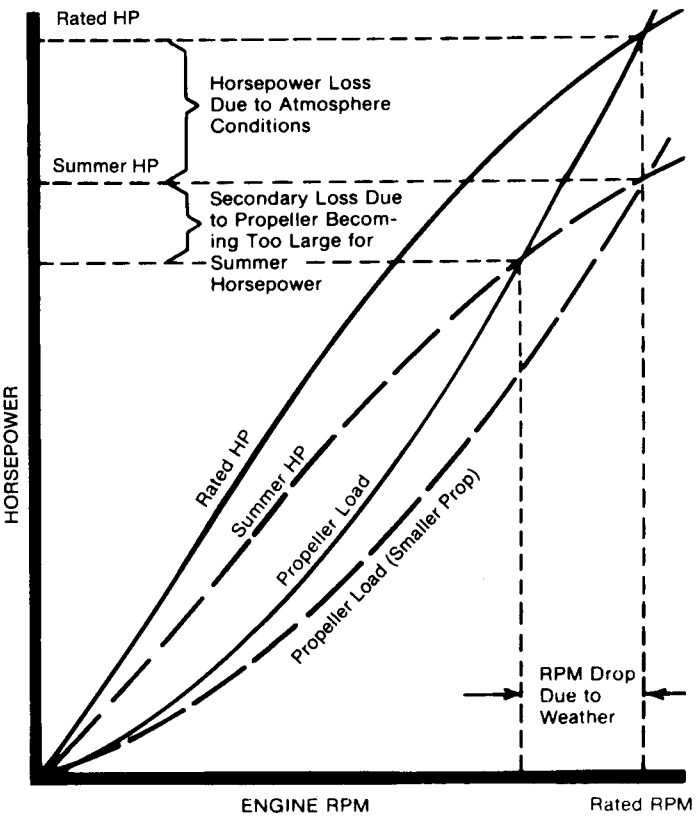
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool, dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip. (See chart)

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.



MAINTENANCE

Location and Service	When Starting Engine Each Day	After First 20 Hours of Operation	Every 50 Hours of Operation
Engine Crankcase Oil - Check level	●		
Closed Cooling Coolant - Check coolant level	●		
Remote Control and Steering System - Check for proper operation	●		
Power Package (Entire) - Observe for obvious leaks (water, fuel, oil, exhaust, etc.)	●		
Ignition System - Check timing and adjust, if necessary		■	
Crankcase Oil and Oil Filter - Change		●	

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MAINTENANCE CHART

Only perform maintenance which applies to your particular power package.

● = To Be Performed by Owner
■ = To Be Performed by an Authorized MerCruiser Dealer
F = Freshwater Areas Only
S = Saltwater Areas Only

TASK	INTERVAL			
Location and Service	Weekly	Every 50 Hours or 60 Days	Every 100 Hours or 120 Days	At Least Once a Year
Engine Crankcase Oil - Check level	●			
Closed Cooling Coolant - Check level	●			
Ignition System - Check timing; adjust if needed				■
Crankcase Oil and Oil Filter - Change			■	■
Power Steering Fluid - Check level	●			
Stern Drive Unit Oil - Check level	●			
Steering System - Lubricate and inspect for loose, damaged or missing parts		S■	F■	■
Battery - Check level and inspect for damage	●			
Electrical System (Entire) - Check for loose or damaged wiring		S■	F■	■
Fuel Pump Sight Tube - Check for fuel	●			
Cooling System Hoses and Clamps - Inspect for damage and deterioration. Check clamps for tightness		S■	F■	■
Engine Exhaust System- Inspect for damage, deterioration and restrictions. Check clamps for tightness		S■	F■	■
Drive Belts (All) - Inspect condition and check tension			●	●
Ignition System - Clean and inspect condition			■	■
Flame Arrestor and Crankcase Ventilation Hose - Clean and inspect			■	■
Continuity Circuit - Check components for loose connections, broken or frayed wires		S■	F■	■
Shift and Throttle Cable and Linkage - Lubricate and inspect for loose, damaged or missing parts		S■	F■	■
Power Trim Pump Oil - Check level	●			

TASK	INTERVAL			
Location and Service	Weekly	Every 50 Hours or 60 Days	Every 100 Hours or 120 Days	At Least Once a Year
Stern Drive Unit Oil - Change			■	■
Propeller Shaft - Lubricate		S●	F●	●
Transom Gimbal Housing Assembly Swivel Shaft and Pin, Hinge Pins and Gimbal Bearing - Lubricate		S■	F■	■
Engine Coupling, Stern Drive Unit Universal Joint and Shaft Splines - Lubricate			■	■
Engine Alignment - Check			■	■
Fuel Filters - Replace				■
Power Package Exterior Surfaces - Clean and paint				●
Steering Head and Remote Control - Inspect and lubricate				■
Quicksilver MerCathode® System - Test output				■
Closed Cooling Coolant - Test for alkalinity				■
Heat Exchanger - Clean seawater section				■
Cooling System - Flush seawater section	S● AFTER USE EACH DAY			
Power Package Exterior Surfaces - Spray with rust preventive		S●	F●	●
Closed Cooling Coolant - Replace	■ EVERY 2 YEARS			
Zinc Alloy Trim Tab, Anodic Heads, Anodic Plate and Quicksilver Anticorrosion Anode Kit (Optional) - Inspect for erosion	●			
Gear Housing Water Pickups - Check for marine growth or debris	●			
Carburetor - Adjust				■

Fluid Capacities

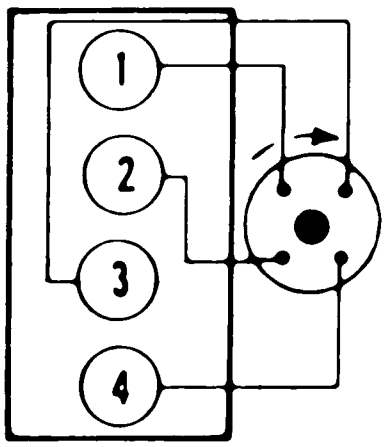
Capacities are approximate fluid measures.

MODEL	MCM 120 - 2.5L MCM 140 - 3.0L
Crankcase (with Filter)	4 Qts. (3.8L)
Standard Cooling System	9 Qts. (8.5L)
Closed Cooling System	9 Qts. (8.5L)

Specifications

MODEL	MCM 120/2.5 Litre	MCM 140	MCM 3.0 Litre
Horsepower (Kilowatts)	120 (90)	140 (104)	130 97
Number of Cylinders	4		
Displacement	153 CID (2.5L)	181 CID (3L)	
Bore/Stroke	3.87 In./3.25 In. (98.3/82.6mm)	4.00 In./3.60 In. (101.6/91.4mm)	
Compression Ratio	8.5:1		9.2:1
Compression Pressure	140 PSI (966 kPa)		
Idle RPM (In Forward Gear)	650-700		
Max. RPM (At W.O.T.)	4200-4600		
Oil PSI (At 2000 RPM)	30-60 PSI (207-414 kPa)		
Min. Oil PSI (At Idle)	4 PSI (28 kPa)		
Fuel Pump PSI (At 1000 RPM)	5 - 6-1/2 PSI (35 - 44 kPa)		
Electrical System	12 Volt Negative (-) Ground		
Min. Battery Requirements	375 / 90Ah		
Firing Order	1-3-4-2		
Spark Plug Type	AC-MR43T	Champion RV15YC4 NGK-BR6FS	
Spark Plug Gap	.035 In. (0.9mm)		
Breaker Point Gap	.022 In. (0.5mm)		
Dwell	28° - 34°		
Breaker Point Spring Tension	19-23 Oz. (540-650g)		
Timing (At Idle RPM)	8° BTDC	6° BTDC	
Preliminary Idle Mixture	1-1/4 Turns		
Thermostat	143°F (62°C)		

L.H. ROTATION
FRONT



Firing Order
1-3-4-2

Left-Hand Rotation Engine Firing Order

Fuel, Oil, Fluid and Coolant Specifications

Fuel

The use of any good grade regular leaded, premium, low-lead or lead-free automotive gasolines with a minimum posted octane rating of US and Canada 87 (R + M/2) all other areas than US and Canada should use 92 RON rating or higher (leadaed or unleaded) fuels, are satisfactory for use in these engines. However, gasolines containing alcohol, either methyl alcohol (methanol) or ethyl (ehtanol) may cause increased:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Fuel permeation through flexible fuel lines.
- Wear and damage of internal engine parts.
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, primer bulbs, fittings, fuel filters and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration necessitates replacement before further engine operation.

Because of the possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only alcohol-containing fuel is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided. Long periods of storage, common to boats, create unique problems: In cars, alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

NO LEAD GASOLINE

U.S. Environmental Protection Agency (EPA) and Canadian government regulations require the removal of lead (anti-knock compound) from all gasoline because lead emission in exhaust is a health hazard.

In order to maintain octane ratings, many gasoline manufacturers are adding ethyl alcohol (ethanol) or methyl alcohol (methanol) to the gasoline to replace the lead.

The use of any good grade unleaded regular or premium gasolines with a minimum posted octane rating US and Canada 87 (R + M/2) all other areas than US and Canada should use 92 RON rating or higher (leaded or unleaded) fuels, are satisfactory for use in your engine. In areas where unleaded regular or premium gasolines are not available, a good grade **leaded** regular with a minimum posted actane rating (A.K.I.) of 89 may be used.

GASOLINE/ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially **METHANOL.** They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine engines. **METHANOL** is more severe in its bad effects than is **ETHANOL.** Alcohol also is more severe in older engines since newer engines have materials which are more resistant to alcohol.

EFFECTS OF GASOLINE/ALCOHOL BLENDS ON MARINE ENGINES

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to fuel tank failure.

Alcohol containing fuels will absorb moisture from the air. At first, this moisture will remain in solution, but once the water content of the fuel has built up to about one-half of one percent, it will separate out, (phase separation) bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, engines can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT/MOTOR STORAGE

When operating a MerCruiser on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

It also is recommended to coat the internal engine parts with Quicksilver Storage Seal. Follow the directions on the container. This coating will reduce possibilities of internal parts becoming rusted from moisture accumulation during storage.

WARRANTY

Performance problems, fuel system or other damage resulting from the use of gasoline-alcohol blended fuels is not the responsibility of Mercury Marine and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline blended with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further, we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is or can be provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space; then, cap the container. The proportions of fuel to water are not critical, but there should be 2-3 times as much fuel as water.
3. Shake container vigorously and allow it to sit upright for up to about 3-5 minutes. **If the volume of water appears to have increased, alcohol is present.** If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

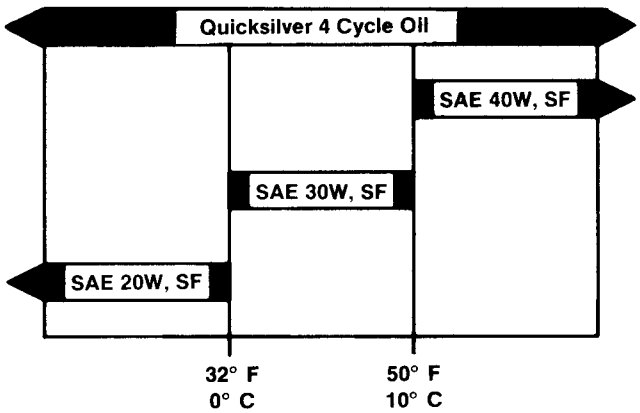
CRANKCASE OIL

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SF, may be used.

The chart below is a guide to crankcase oil selection. Oil filter should always be changed with oil.

In those areas where recommended straight weight oil is not available, a multi-viscosity 20W-40 (SF) or, as a second but less preferable choice, 20W-50 (SF) may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than 20W-40 or 20W-50), low quality oils or oils which contain solid additives specifically are not recommended.



Power Steering Fluid

IMPORTANT: Use only Quicksilver Power Trim and Steering fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

Coolant

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

MerCruiser engines can use any type of permanent anti-freeze or any brand anti-freeze solution that meets G.M. specification 1825M.

Maintaining Crankcase Oil Level

Overfilled Engine Crankcase

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter", on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down". This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the "ADD" mark and the "FULL" mark on the dipstick. To ensure that you are not getting "false reading", make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, OR
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase, if engine has just been run or oil has just been added.

Checking Engine Oil Level/Filling

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick. Wipe clean and reinstall. Push dipstick all-the-way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the "FULL" and "ADD" marks.
6. If oil level is below "ADD" mark, proceed to 7 and 8.
7. Remove oil filler cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, the "FULL" mark on dipstick.

Changing Oil and Filter

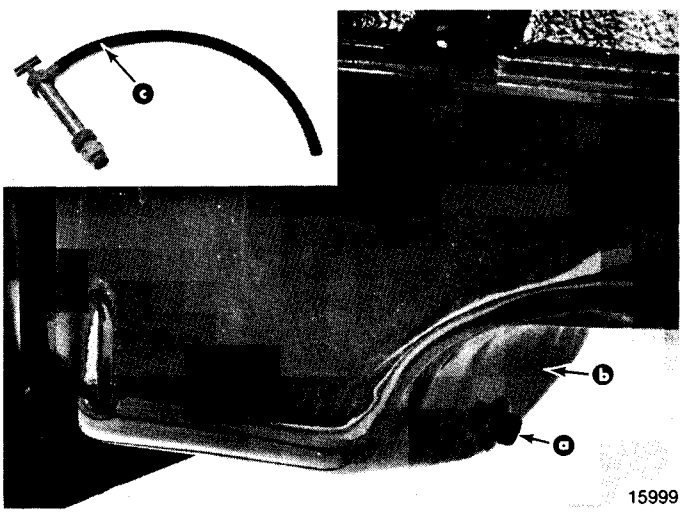
1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan.

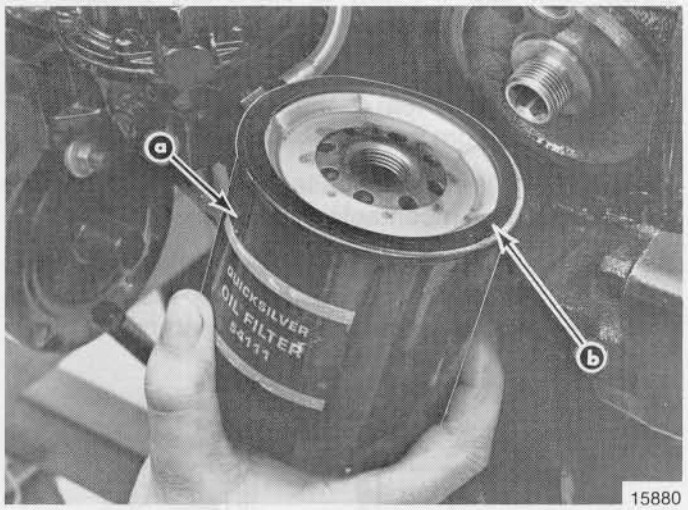
NOTE: If drain plug is not accessible because of boat construction, oil may be removed thru dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)

4. After oil has drained completely, reinstall drain plug and tighten securely.



a - Drain Plug
b - Oil Pan
c - Quicksilver Crankcase Oil Pump

5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install new filter. Tighten filter securely (following filter manufacturer's instructions). But do not over-tighten
7. Fill crankcase with oil.

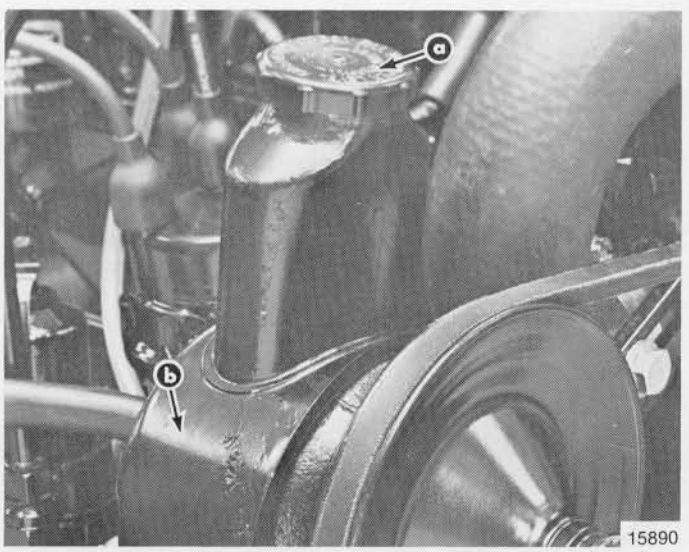


a - Oil Filter
b - Sealing Ring

Maintaining Power Steering Pump Fluid Level

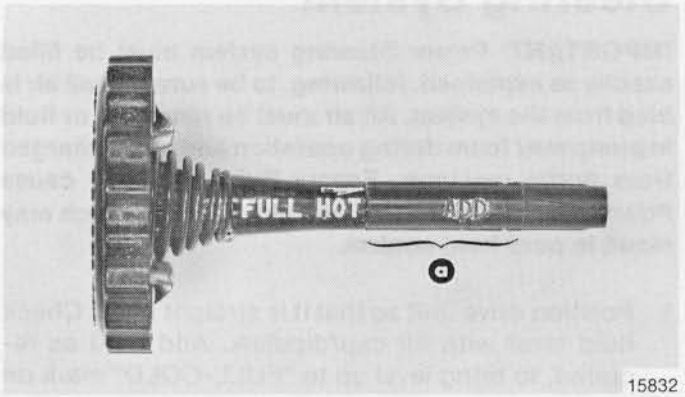
With Engine Warm from Operation

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.



a - Fill Cap/Dipstick
b - Pump

3. Level should be between the "FULL HOT" mark and "ADD" mark on dipstick.

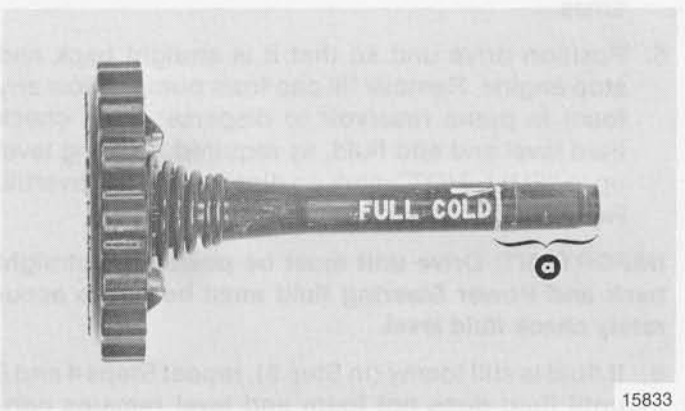


a - Proper Fluid Level with Engine Warm

4. If level is low (below "ADD" mark), but fluid is still visible in pump reservoir, add required amount of fluid thru fill cap opening, to bring level up to "FULL HOT" mark on dipstick - do not overfill.
5. If fluid is not visible in reservoir, a leak exists in Power Steering System.

With Engine Cold

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.
3. Level should be between "FULL COLD" mark and bottom of dipstick.



a - Proper Fluid Level with Engine Cold

4. If fluid level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of fluid, thru fill cap opening, to bring level up to "FULL COLD" mark on dipstick - Do not overfill.
5. If fluid is not visible in reservoir, a leak exists in Power Steering System.

Filling and Bleeding Power Steering System

IMPORTANT: Power Steering system must be filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Check fluid level with fill cap/dipstick. Add fluid as required, to bring level up to "FULL-COLD" mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering fluid, or Dexron II automatic transmission fluid (ATF), in power steering system.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then, recheck fluid level and add fluid, if necessary.
3. Install fill cap/dipstick.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump in stern drive unit, or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse; then, check fluid level and add fluid, as required, to bring level up to "FULL-HOT" mark on dipstick. Do not overfill. Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and Power Steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Maintaining Coolant Level

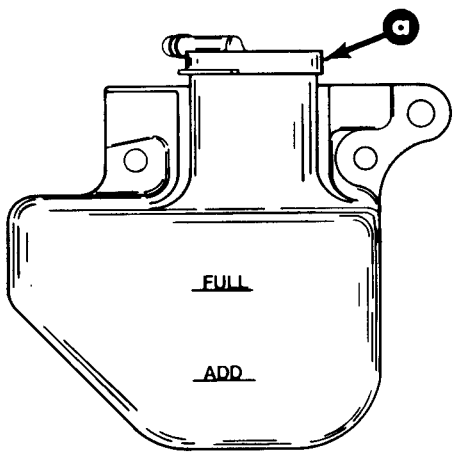
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly; then, push down and turn cap all-the-way off.

1. Coolant level in heat exchanger should be within 1 in. (25mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stop on filler neck.

2. Coolant level should be between the "ADD" and "FULL" mark on coolant recovery reservoir with engine at normal operating temperature.



193-HR

a - Coolant Recovery Reservoir

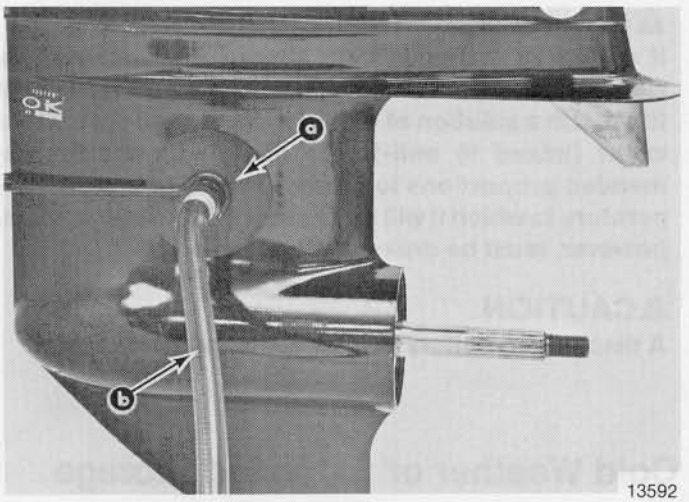
Flushing Cooling System

⚠CAUTION

DO NOT run engine above 1500 RPM when flushing, as suction created by seawater pickup pump in drive unit may collapse garden hose and cause engine and/or drive unit to overheat.

Boat Out-of-Water

1. Install Flush Test Device over water pickup holes in gear housing. Attach a garden hose between the device and water tap.



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a - Flush Test Device
b - Hose

2. Partially open water tap (approximately 1/2 maximum capacity). Do not use full city water pressure.

⚠WARNING

When flushing cooling system, be certain that area in vicinity of propeller is clear and that no person(s) is nearby. As a precautionary measure, it is recommended that propeller be removed.

3. Place remote control in neutral, idle speed position, and start engine.
4. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear; then, stop engine.
5. Shut off water tap. Remove Flush Test Device and garden hose.

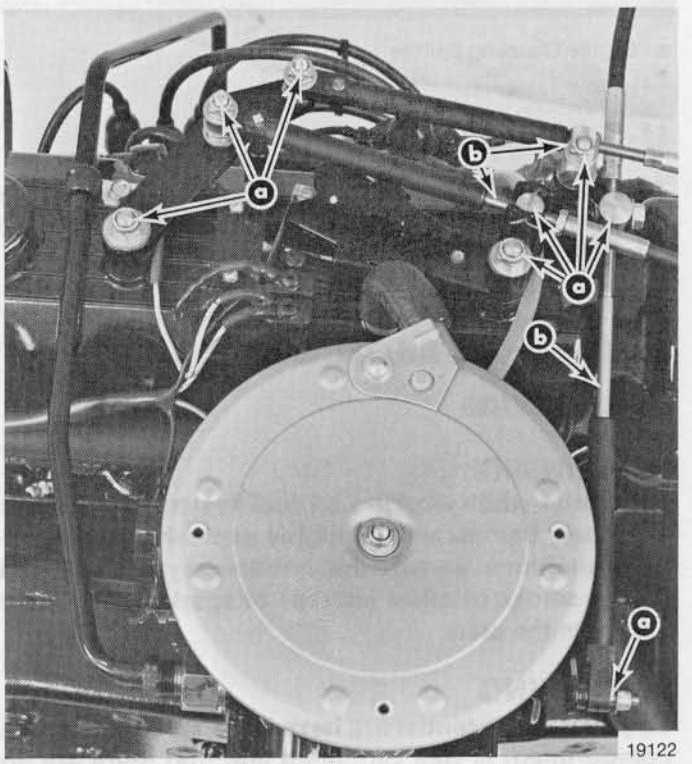
Boat In-the-Water

1. Raise drive unit to full "Up" position.
2. Install Flush Test Device over water pickup holes in gear housing. Attach a garden hose between the device and water tap.
3. Lower drive unit to full "In" position.
4. Follow Steps 2 thru 4 under "Boat Out-of-Water".
5. Shut-off water tap.
6. Raise drive unit to full "Up" position - Remove Flush Test Device and garden hose.

Lubrication

Throttle and Shift Cable

1. Lubricate pivot points with SAE 30 engine oil.
2. Lubricate cable end guide contact surfaces with Quicksilver 2-4-C Marine Lubricant.



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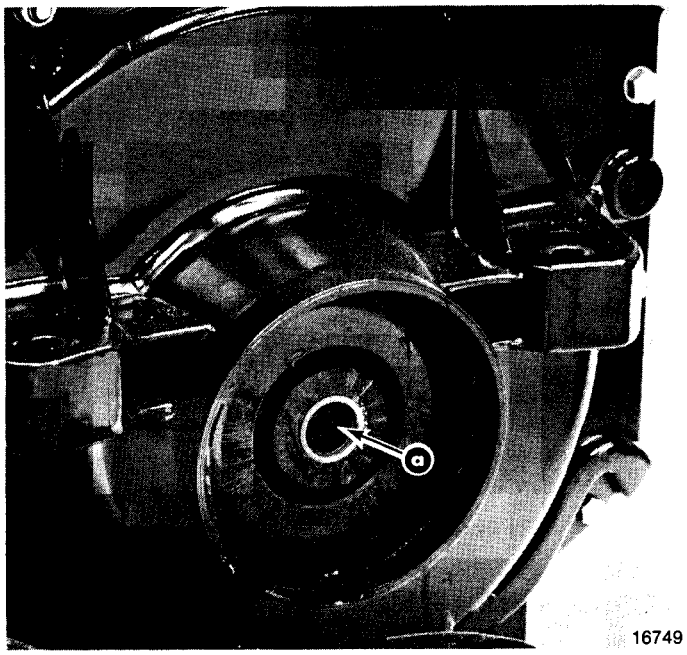
a - Pivot Points
b - Guide Contact Surface

Engine Coupling

1. Lubricate engine coupling splines with Quicksilver Engine Coupler Spline Grease.



a - Engine Coupling Splines

U-Joint Splines

1. Lubricate U-joint shaft splines and O-rings with Quicksilver Engine Coupler Spline Grease. Refer to "MerCruiser Stern Drive Service Manual.

Out-of-Season Storage

Precautions

⚠WARNING

Be careful while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF" and do not smoke or allow sources of spark and/or open flames in the area.

⚠WARNING

To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION

Cooling system must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine. If engine has been exposed to freezing temperatures, the boat should be placed in a warm area before attempting to run engine or drain cooling system.

⚠CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section of cooling system must be kept filled with a solution of ethylene glycol anti-freeze and water (mixed to anti-freeze manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). Seawater section, however, must be drained completely.

⚠CAUTION

A discharged battery can be damaged by freezing.

Cold Weather or Extended Storage

NOTICE

Refer to "Precautions", in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer and Conditioner to treat the gasoline.

IMPORTANT: If boat is to be placed in storage (with fuel containing alcohol in fuel tanks), carburetors must be run dry at idle RPM. Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Also, refer to "Fuel Requirements"; see "Index".

2. Replace all fuel filters.
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to bring it up to normal operating temperature. Shut off engine and change oil and filter.
5. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system.

6. Remove flame arrestor assembly and restart engine. While operating engine at fast idle (100-1500 RPM), fog internal surfaces of induction system and combustion chanbers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal Rust Inhibitor or SAE 20 SE engine oil into carburetor bores. Stall engine by squirting 2 ounces (57 grams) of Storage Seal Rust Inhibitor or oil rapidly into carburetor. Turn ignition "OFF".
7. Close fuel shut off valve, if so equipped.
8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items outlined in "Lubrication".
10. Closed Cooling System Models, test coolant in closed cooling section to ensure that it will withstand lowest temperature expected during storage.
11. Service batteries
12. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion Guard or wipe down with SAE 20 SE engine oil.
13. For Stern Drive Unit, refer to "Stern Drive Manual".

Draining Instructions Seawater Cooling

Draining Precautions

IMPORTANT: If the possibility of freezing exists, cooling system must be drained to prevent freeze damage to cooling system. Cooling system also should be drained if boat is to be stored for an extended period of time to prevent corrosion damage.

⚠CAUTION

Cooling system, must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

⚠CAUTION

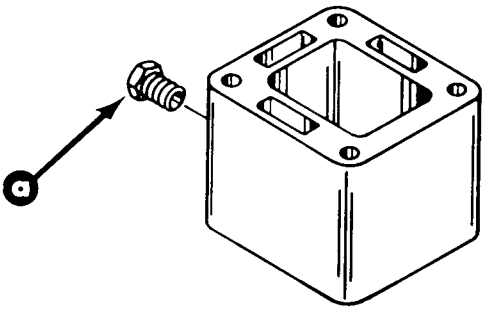
If boat is in the water, water inlet valve (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

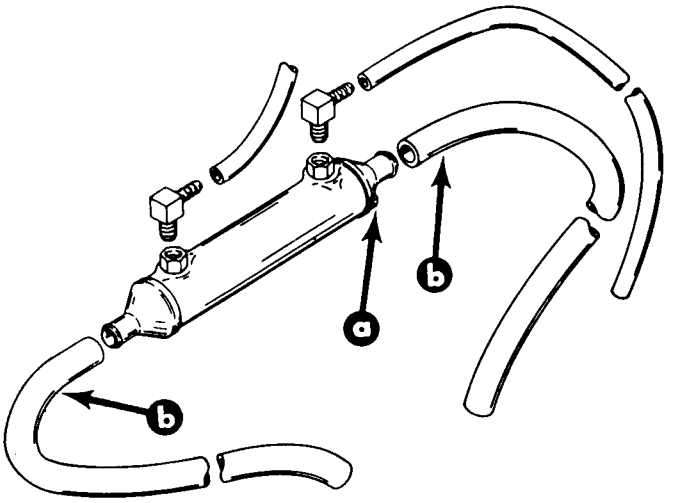
NOTE: If possible, place a container under drains to prevent water from draining into boat.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.



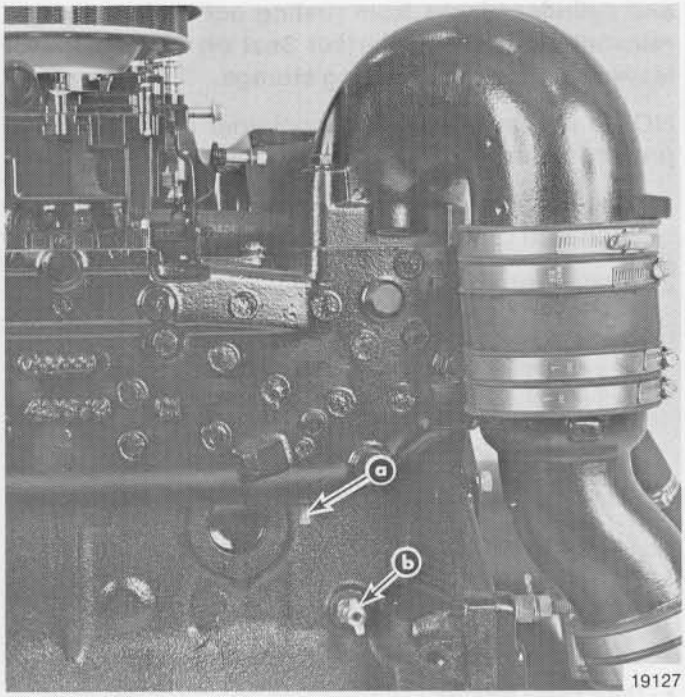
a - Drain Plug - Remove

3" or 6" Risers (If Equipped)



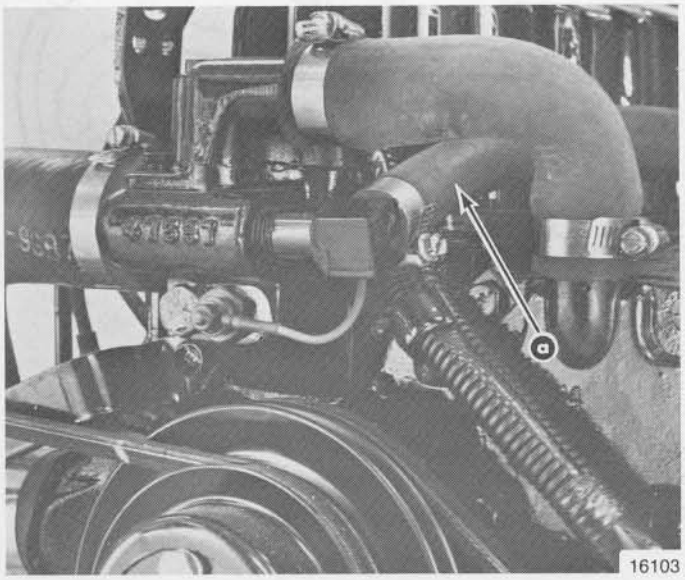
a - Drain Plug - Remove
b - Cooler Without Drain Plug - Remove Hoses

Power Steering Fluid Cooler (If Equipped)



a - Drain Plug
b - Petcock

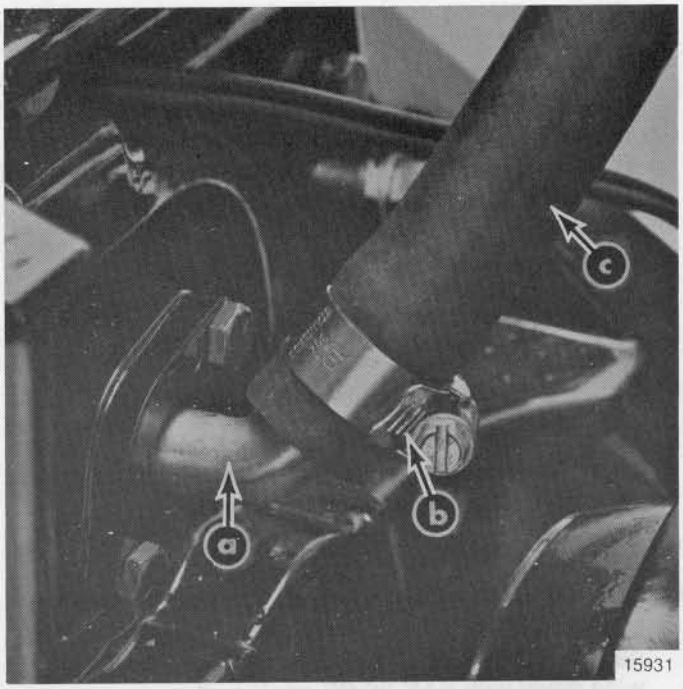
Engine Drain Location



a - Remove Hose and Lower to Drain

Draining Inlet Hose

3. **Drive Shaft Extension Models:**
   Disconnect water inlet hose from gimbal housing. Lower to drain hose (and power steering fluid cooler, if equipped).



a - Water Tube
b - Hose Clamp (Tighten Securely)
c - Water Hose

4. **Power Steering Models:** Fluid cooler will drain back thru stern drive unit.
5. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock.
6. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage).

a - Remove Cover and Thermostat. Fill with Coolant until Block and Head are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hose. Fill Manifold with Coolant. Reinstall Hose and Tighten Clamp Securely

Draining Instructions Closed Cooling

Closed Cooling Section

Closed cooling section of Closed Cooling System should be kept filled year around with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol anti-freeze and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

Draining Seawater Section

⚠CAUTION

If the possibility of freezing exists, seawater section must be drained to prevent freeze damage to cooling system and engine. Seawater section also should be drained if boat is to be stored for an extended period of time, to prevent corrosion damage.

⚠CAUTION

If boat is in the water, water inlet valve (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

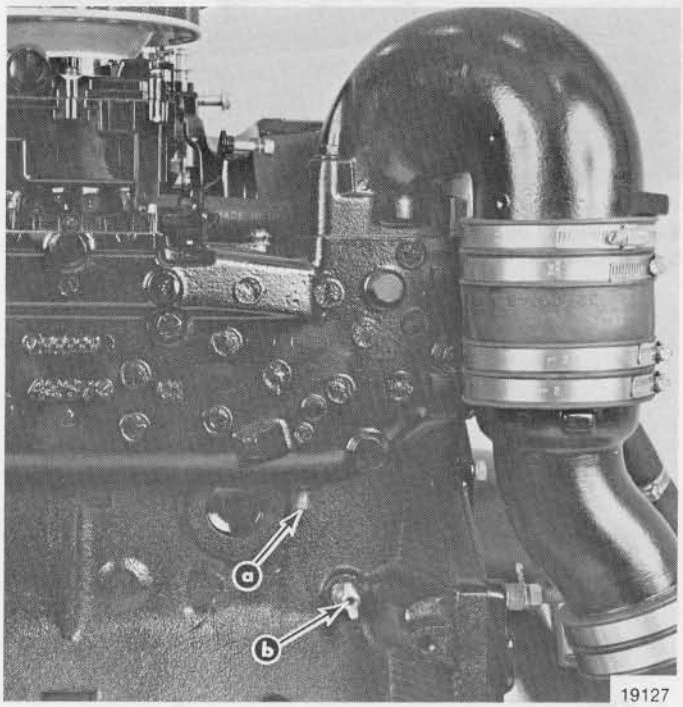
IMPORTANT: To prevent threads from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: If possible, place a container under drains to prevent water from draining into boat.

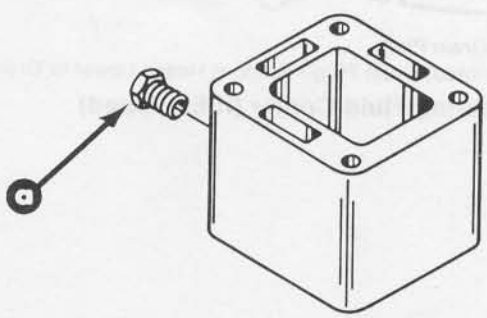
NOTICE

Refer to "Draining Precautions", in this section, before proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.

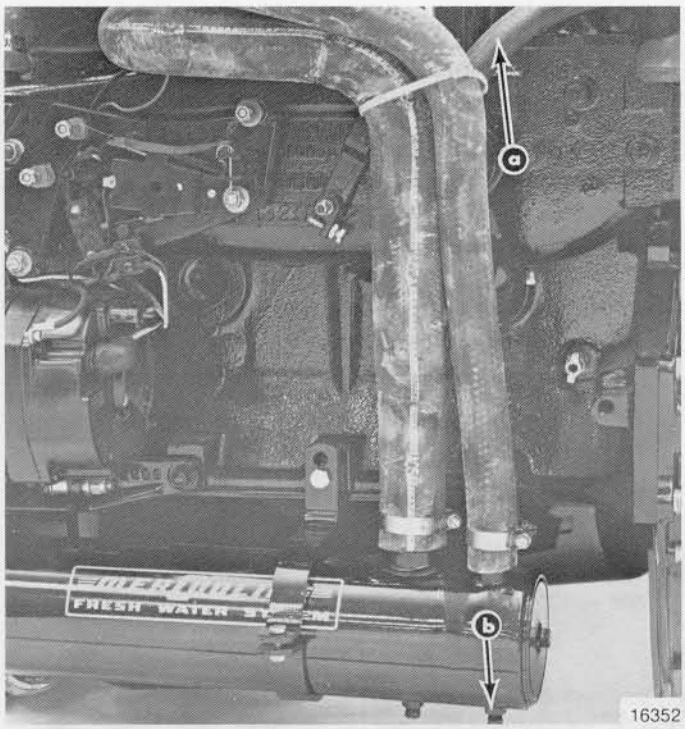


a - Drain Plug
b - Petcock

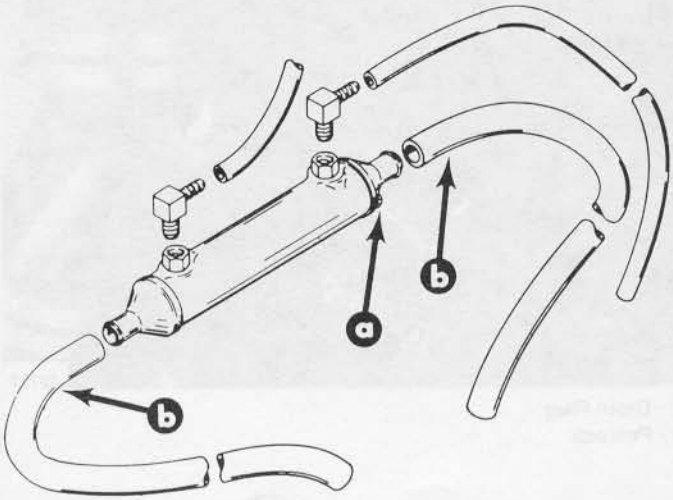


a - Remove Drain Plug

3" or 6" Risers (If Equipped)



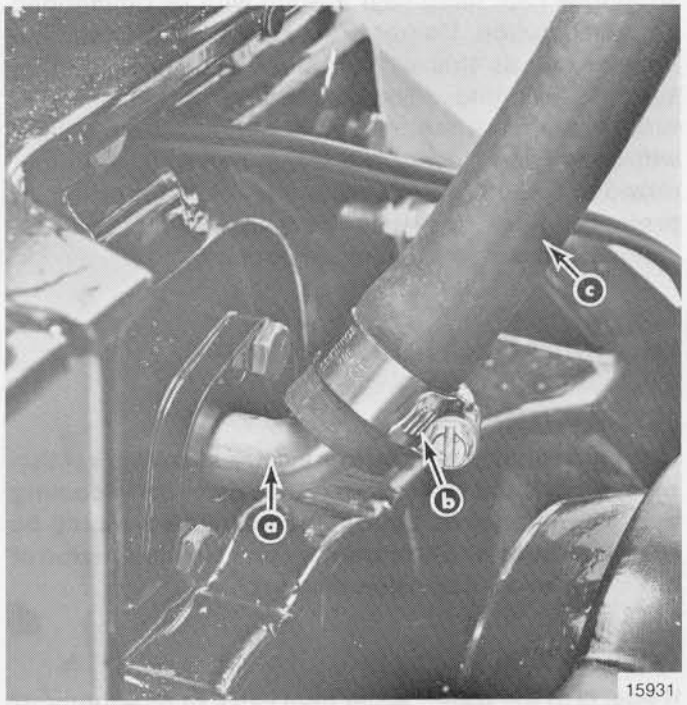
a - Disconnect Seawater Inlet Hose and Lower to Drain
b - Remove Drain Plug (1)



a - Remove Drain Plug
b - Cooler without Drain Plug - Remove Hoses Lower to Drain

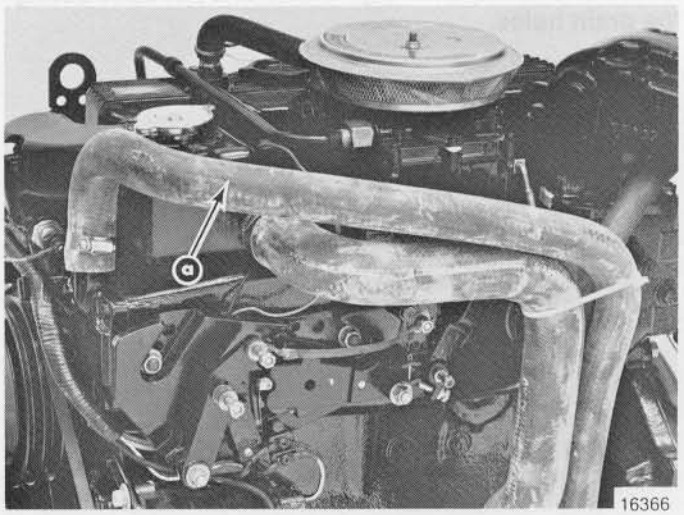
Power Steering Fluid Cooler (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hose and tighten clamp securely.
4. **Driveshaft Extension Models:** Disconnect water inlet hose from gimbal housing and lower to drain hose.



a - Water Tube
b - Hose Clamp (Retighten Securely)
c - Remove Hose, Lower to Drain

5. For additional assurance against freezing and rust, fill the exhaust manifold and heat exchanger with a solution of permanent anti-freeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill manifold and exchanger refer to figure shown.



a - Remove Hose From Manifold End Cap. Pour Coolant into Manifold, Then into Hose until Heat Exchanger if Full. Reconnect Hose. Tighten Clamp Securely

Filling Closed Cooling Section

NOTICE
See "Specifications" for appoximate closed cooling system capacity and coolant recommendation.

1. Fill closed cooling section with coolant as follows:
   a. Thru reservior filler neck until coolant solution is 1" (25mm) below filler neck.

⚠CAUTION
Do not operate engine without water flowing thru seawater pickup pumps, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the posibility of air being trapped in the closed cooling section which can cause engine to overheat.

Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.

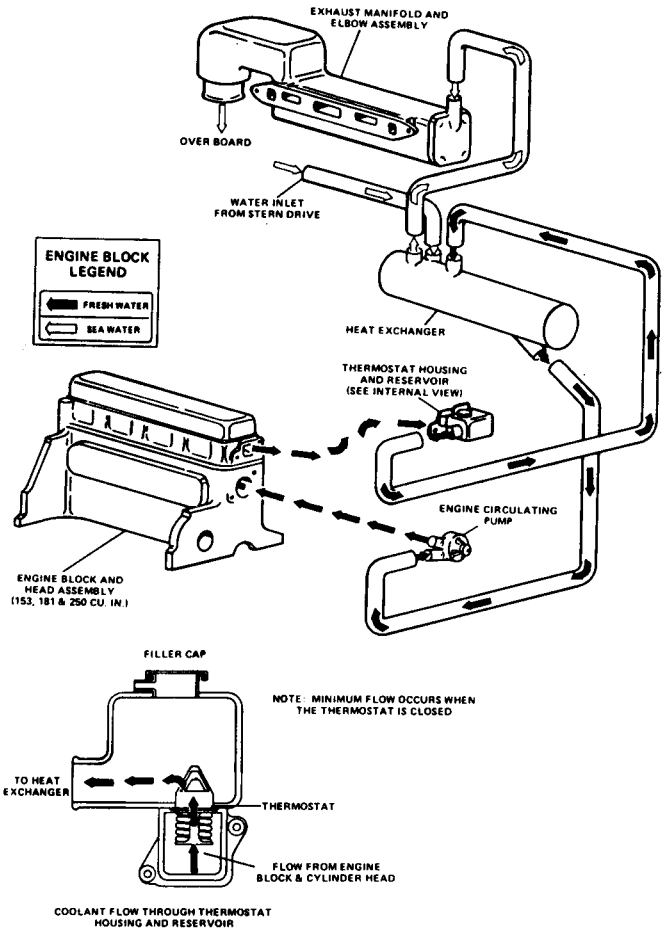
2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1" below filler neck.
3. After engine has reached normal operating temperature (themostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on heat exchanger.
6. Remove cap from coolant recovery reservoir and fill to "Full" mark with coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat step 4.

IMPORTANT: Engine overheating is often due to air being trapped in fresh water section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING
Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

8. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
9. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

Cooling System Flow Diagrams



Recommissioning

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are in and tight.
2. Inspect all drive belts.
3. Check engine alignment.
4. Perform ALL lubrication and maintenance specified for completion "At Least Once Each Year" in "Maintenance Chart", except items which were performed at time of engine layup.
5. Install Stern Drive unit (refer to "Stern Drive Manual").

⚠CAUTION

When installing battery (in next step), be sure to connect negative (grounded) battery cable to negative (-) battery terminal and positive battery cable to positive (+) terminal. If battery cables are reversed, damage to electrical system WILL result.

6. Install fully-charged battery. Clean battery cable clamps and terminals and reconnect cables. Be sure to tighten clamps securely. Apply a thin coat of petroleum base grease to clamps and terminals to help retard corrosion.
7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check fuel pump sight tube.
10. Check steering system and shift and throttle control for proper operation.

TROUBLESHOOTING

1 C

CAUSE	SPECIA
1. Moisture on ignition components	1. Distributor cap or spa
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interruptor switch	5. Disconnect tachom
5. Shorted tachometer	
6. Ignition timing	7. Fouled, burned, cr
7. Spark plugs	8. Faulty insulation,
8. Spark plug wires	
9. Cracked or dirty distributor cap	10. Check compone
10. Faulty ignition components	11. Synchronizers m (parallel circuit)
11. Engine synchronizer (if equipped) hooked up in series on ignition wire (dual engines only)	

NOTICE
Refer to "Precautions", BEFORE proceeding with troubleshooting.

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PRECAUTIONS

⚠WARNING
Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING
Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION
DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out-of-water, if instructions, under "Running Engine with Boat Out-of-the-Water", following, are completed.

⚠WARNING
When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠WARNING
Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE.

⚠WARNING
DO NOT leave helm unattended while performing idle speed adjustment.

USED SPARK PLUG ANALYSIS

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

A. Remove any oil deposits with solvent and dry plugs thoroughly.

B. Open electrode gap wide enough to permit cleaning and filing.

C. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.

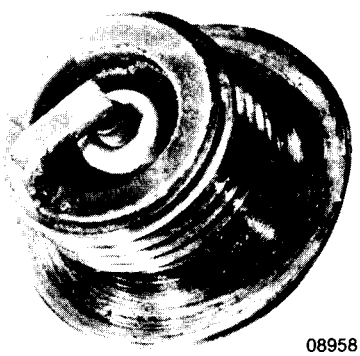
D. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.

E. Reset gap to specifications by bending only side electrode with proper tool.

SPARK PLUG ANALYSIS

NORMAL CONDITION

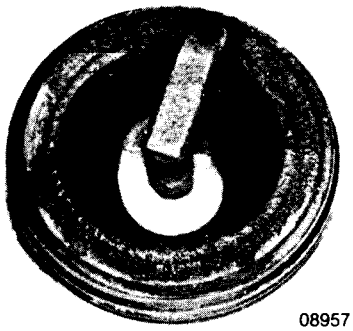
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.



08958

CHIPPED INSULATOR

Chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.



08957

WET FOULING (OIL DEPOSITS)

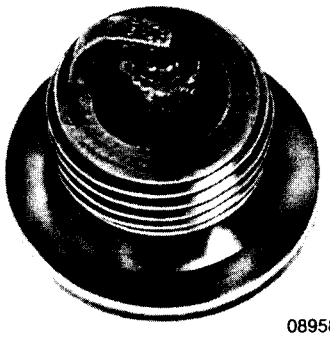
Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.

08958

COLD FOULING

Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If only one or two plugs in set are fouled, however, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and regap) plugs and reinstall.



08958

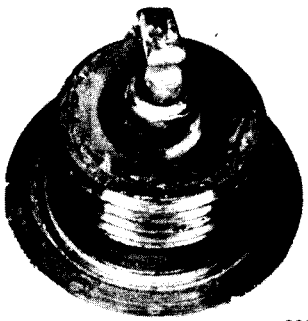
OVERHEATING

Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.

08957

HIGH SPEED GLAZING

Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition re-occurs, use colder heat range plug and service plugs more frequently.



08958

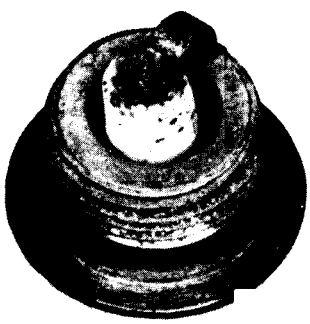
SCAVENGER DEPOSITS

Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is a normal appearance with certain branded fuels. Accumulation on ground electrode and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and regap) and reinstalled.

08958

PRE-IGNITION DAMAGE

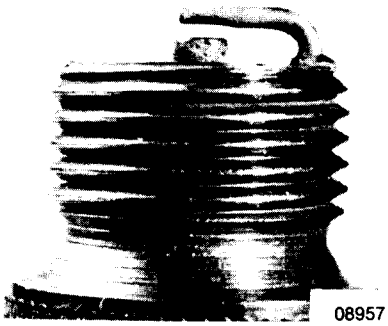
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.



08957

REVERSED COIL POLARITY

Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



08957

SPLASHED DEPOSITS

Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and reinstall.

08958

MECHANICAL DAMAGE

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust manifold to prevent further damage.

08957

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

POOR BOAT PERFORMANCE and/or POOR MANEUVERABILITY

SYMPTOM	CAUSE
1. Bow too low	1. A. Improper drive unit trim angle B. Improper weight distribution C. Boat is underpowered D. Permanent or power hook in boat bottom E. False bottom full of water F. Improperly adjusted trim tabs (after planes)
2. Bow too high	2. A. Improper drive unit trim angle B. Propeller pitch too great C. Dirty boat bottom (marine growth) D. Poor running engine E. Improper weight distribution F. Rocker in boat bottom G. False bottom full of water H. Improperly adjusted trim tabs (after planes)
3. Propeller ventilating	3. A. Drive unit installed too high on transom B. Dirty or rough boat bottom C. Damaged propeller, pitch too small, diameter too small D. Keel located too close to propeller or too deep in the water E. Water pick-up or accessories located too close to propeller F. Hook in boat bottom G. Propeller plugged up with weeds

IMPROPER FULL THROTTLE ENGINE RPM

RPM TOO HIGH

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged, pitch too low, diameter too small, propeller hub slipping.
2. Boat	2. Water pick-up or accessories mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom, wrong gear ratio.
3. Operation	3. Drive unit trimmed out too far.
4. Engine coupler slipping	

RPM TOO LOW

CAUSE	SPECIAL INFORMATION
1. Propeller	1. Damaged, pitch too great, diameter too great.
2. Boat	2. Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
3. Operation	3. Drive unit trimmed in too far.

ENGINE CRANKS OVER BUT WILL NOT START OR STARTS HARD

Important Information

First, determine which engine system is causing the problem. To make an engine run basic components - fuel, spark (ignition), and compression are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.

1. Determine if there is fuel present by looking down carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
2. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure the plugs are correct type and heat range, and not fouled or burned.
3. Run a compression check on engine to make sure the engine is mechanically OK.

CONVENTIONAL IGNITION (NO SPARK)

CAUSE	SPECIAL INFORMATION
1. Moisture on ignition components	1. Distributor cap or spark plug leads arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	3. May run in start position and lose spark in the run position
4. Shift interruptor switch	
5. Shorted tachometer	5. Disconnect tachometer and try again.
6. Ignition timing	6. May crank over hard, backfire, or try to run backwards
7. Faulty ignition resistor wire or bypass wire	
8. Ignition points improperly gapped, burned or dirty	
9. Spark plugs	9. Fouled, burned, cracked porcelain
10. Spark plug wires	10. Faulty insulation, broken wires
11. Cracked or dirty distributor cap or rotor	
12. Coil	
13. Condenser	

FUEL SYSTEM RICH

CAUSE	SPECIAL INFORMATION
1. Warm engine carburetor percolation	1. Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
2. Clogged flame arrestor	
3. Automatic choke not opening	
4. Float adjustment	
5. Float leaks or is saturated with fuel	
6. Needle and seat leaking	
7. Carburetor gaskets leaking	
8. Excessive fuel pump pressure	8. Unseats needle and seat
9. Cracked or porous carburetor body	

FUEL SYSTEM LEAN

CAUSE	SPECIAL INFORMATION
1. Empty fuel tank	
2. Fuel shut off valve closed (if equipped)	
3. Anti-siphon valve stuck closed (if equipped)	
4. Vapor lock	4. Engine will not start after warm engine shut down
5. Automatic choke	5. Stuck open, wrong adjustment
6. Fuel tank vent plugged	6. Engine will start initially. After a short time of running, engine will stall and will not restart for a period of time. Can varify it is a vent problem by running engine with filler cap loose. Filler cap will act as a vent.
7. Air leak on suction side of fuel system	7. Sucks air into fuel system reducing fuel volume
8. Plugged or pinched fuel line	
9. Fuel pump	9. Low pump pressure

MISCELLANEOUS

CAUSE	SPECIAL INFORMATION
1. Low grade or stale fuel	
2. Water in fuel	
3. Vacuum leak	
4. Low compression	4. Worn valves, rings, cylinder, or head gasket
5. Valve timing incorrect	5. Timing or gears improperly installed

ENGINE WILL NOT CRANK OVER

CAUSE	SPECIAL INFORMATION
1. Control lever not in neutral position	
2. Battery charge low; damaged wiring; loose electrical connections	
3. Blown fuse at starter motor	3. On early models with red wire going to fuse on starter terminal.
4. Circuit breaker tripped	
5. Ignition switch	
6. Slave solenoid	
7. Faulty neutral start safety switch	7. Open circuit.
8. Starter solenoid	
9. Starter motor	

CHARGING SYSTEM INOPERATIVE

CAUSE	SPECIAL INFORMATION
1. Loose or broken drive belt	
2. Engine RPM too low on initial start	2. Rev engine to 1500 RPM
3. Loose or corroded electrical connections	
4. Faulty ammeter or battery gauge	4. Best way to test is to replace gauge
5. Battery will not accept charge	5. Low electrolyte, failed battery
6. Faulty alternator or regulator	
7. Failed fuse (if so equipped)	7. Fuse located on starter terminal stud. Orange output wire from alternator connects to fuse.
8. Refer to "Section 4 Part C" for complete Charging System troubleshooting procedures.	

NOISY ALTERNATOR

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Worn, frayed, loose.
2. Loose drive pulley	
3. Worn or dirty bearings	
4. Faulty stator	
5. Faulty diode trio or stator	

INSTRUMENTATION MALFUNCTION

CAUSE	SPECIAL INFORMATION
1. Faulty wiring, loose or corroded terminals	
2. Bad key switch	2. Test, as outlined in "Section 4, Part D"
3. Faulty gauge	3. Test, as outlined in "Section 4, Part D"
4. Faulty sender	4. Test, as outlined in "Section 4, Part D"

RADIO NOISE

CAUSE	SPECIAL INFORMATION
1. A "popping" noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	1. Ignition System - wrong spark plugs, cracked distributor cap, cracked coil tower, leaking spark plug wires, moisture on ignition components.
2. A "hissing or crackling" noise when instruments are jarred with ignition on	2. Instrumentation - loose connections, or antennae wire routed too close to instruments.
3. Varying unexplained noises	3. Accessories - bilge pump, bilge blower, fish finder, depth locator, cabin heater motor, etc. Disconnect one at a time until noise disappears.

POOR FUEL ECONOMY

CAUSE	SPECIAL INFORMATION
1. Fuel leaks	
2. Operator habits	2. Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution
3. Engine laboring	3. Bent, damaged, wrong propeller. Water test boat for proper operating RPM at WOT.
4. Clogged flame arrestor	
5. Engine compartments sealed too tight	
6. Boat bottom	6. Dirty (marine growth), hook, rocker
7. Carburetor	7. Idle mixture settings, accelerator pump adjustment, linkage binding, choke adjustment, carburetor flooding over, main fuel jets
8. Improper fuel	
9. Crankcase ventilation system not working	
10. Engine needs tune-up	
11. Engine running too cold or too hot	
12. Plugged or restricted exhaust	
13. Engine	13. Low compression.

CARBURETOR MALFUNCTIONS

SYMPTOM	CAUSE
1. Flooding	1. A. Needle and seat B. Float adjustment C. Saturated float D. Gaskets leaking E. Cracked fuel bowl F. Fuel percolation G. Electric choke
2. Rough idle	2. A. Idle RPM too low B. Idle mixture screws C. Idle passages dirty D. Throttle valves not closing E. Engine flooding F. Vacuum leak G. Throttle body heat passages plugged
3. Hesitation or acceleration flatness	3. A. Accelerator pump B. Leaking gaskets C. Electric choke D. Power piston or power valve E. Throttle valves F. Throttle body heat passages plugged G. Main metering jets H. Float adjustment
4. Engine surges	4. A. Main metering jets B. Leaking gaskets C. Float adjustment D. Saturated float E. Power piston or valve F. Throttle valves
5. Low top speed or lack of power	5. A. Power piston or valve B. Float adjustment C. Main metering jets D. Leaking gaskets
6. Poor cold engine operation	6. A. Idle RPM too low B. Idle mixture screws C. Throttle valves D. Electric choke E. Engine flooding
7. Engine stalls	7. A. Idle RPM too low B. Idle mixture screws C. Engine flooding D. Automatic choke E. Dirt in carburetor F. Accelerator pump G. Leaking gaskets
8. Hard starting	8. Refer to "Engine Starts Hard"

ENGINE RUNS POORLY AT IDLE

CAUSE	SPECIAL INFORMATION
1. Clogged flame arrestor	
2. Improper idle fuel mixture adjustment	
3. Moisture on ignition components	3. Cap or spark plug wires arcing
4. Water in fuel	
5. Low grade or stale fuel	
6. Incorrect ignition timing	
7. Automatic choke	
8. Spark plugs	8. Fouled, burned, cracked porcelain
9. Incorrect point gap, burned or pitted points	
10. Spark plug wires	10. Insulation break down, wires broken
11. Defective coil or condenser	
12. Cracked or dirty distributor cap	
13. Incorrect float level	
14. Dirty carburetor	
15. Vacuum leak	15. Leak at manifold or carburetor base
16. Incorrect fuel pump pressure	16. Too low, can't supply the carburetor Too high, unseats the needle and seat
17. Low compression	17. Also check for blown head gasket
18. Loose or worn distributor	18. Timing and/or dwell changes
19. Water leaking into cylinders	19. Head gasket, exhaust manifold, cracked head or valve seat
20. Loose or broken engine mounts	

ENGINE ACCELERATION IS POOR

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance"	1. See "Index".
2. Idle mixture screws	
3. Air valve spring out of adjustment	3. Rochester 4 barrel carburetor only.
4. Incorrect ignition timing	
5. Incorrect distributor advance curve	5. Refer to Section 4, Part B.
6. Accelerator pump	6. Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off.
7. Cracked or dirty distributor cap or rotor	
8. Vacuum leak	8. Manifold or carburetor base.
9. Spark plugs	9. Fouled, burned; wrong heat range; cracked porcelain.
10. Incorrect point gap; dirty or burned points	
11. Float adjustment	
12. Dirty carburetor	
13. Low compression	

ENGINE RUNS POORLY AT HIGH RPM

CAUSE	SPECIAL INFORMATION
1. Also refer to "Poor Boat Performance"	1. See "Index".
2. Crankcase over-filled with oil	2. Check oil level with boat at rest in the water. Refer to Section 1, Part B.
3. Anti-siphon valve (if equipped)	3. Restricting fuel supply.
4. Plugged fuel tank vent	
5. Fuel supply	5. Refer to "Carburetor Malfunctions". (See "Index".)
6. Ignition timing	
7. Low grade of fuel or water in the fuel	
8. Spark plugs	8. Fouled, burned, cracked porcelain, incorrect heat range.
9. Spark plug wires	9. Poor insulation, broken wires.
10. Distributor cap or rotor	10. Dirty or cracked.
11. Coil	
12. Distributor	12. Points, condenser, worn cam, excessive play in shaft.
13. Engine overheating	13. Refer to "Engine Overheats". (See "Index".)
14. Low compression	14. Worn valves, rings, cylinders, etc.
15. Restricted exhaust	

TROUBLESHOOTING WITH VACUUM GAUGE

READING	CAUSE
1. Steady reading betweeen 15-21 inches at idle RPM	1. Normal.
2. Extremely low reading, but steady at idle RPM	2. Vacuum leak; incorrect timing; under powered boat; faulty boat bottom.
3. Fluctuates between high and low at idle RPM	3. Blown head gasket between 2 adjacent cylinders.
4. Fluctuates 4 or 5 inches very slowly at idle RPM	4. Carburetor needs adjustment; spark plug gap too narrow; valves are sticking.
5. Fluctuates rapidly at idle, steadies as RPM is increased	5. Valve guides are worn.
6. Continuously fluctuates between low and normal reading at regular intervals at idle RPM	6. Burned or leaking valve.

ENGINE NOISE

IMPORTANT INFORMATION

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed, are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine. Front to back; top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and, loose flywheel cover. In many cases, if this is found to be the problem, a complete engine tear down is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine or drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

VALVE COVER AREA

LOCATION	POSSIBLE CAUSES
1. Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders.	1. A. Rocker arm striking valve cover B. Rocker arm out of adjustment C. Worn rocker arm D. Bent push rod E. Collapsed lifter

CYLINDER AREA

LOCATION	POSSIBLE CAUSES
1. Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	1. A. Sticking valve B. Carbon build-up C. Connecting rod installed wrong D. Bent connecting rod E. Piston F. Piston rings G. Piston pin H. Cylinder worn

CAMSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Camshaft area, front of engine, timed to one-half engine speed	1. A. Camshaft timing sprocket B. Fuel pump C. Valve lifter D. Cam bearings
2. Camshaft area, center of engine, timed to one-half engine speed	2. A. Fuel pump B. Valve lifter C. Cam bearings
3. Camshaft area, rear of engine, timed to one-half engine speed	3. A. Distributor gear B. Valve lifter C. Cam bearings
4. Camshaft area, throughout engine, timed to one-half engine speed	4. A. Loss of oil pressure B. Valve lifters C. Cam bearings

CRANKSHAFT AREA

LOCATION	POSSIBLE CAUSES
1. Crankshaft area, front of engine, timed to engine speed	1. A. Crankshaft timing sprocket B. Main bearing C. Rod bearing
2. Crankshaft area, center of engine, timed to engine speed	2. A. Crankshaft striking pan or pan baffle B. Main bearing C. Rod bearing
3. Crankshaft area, rear of engine, timed to engine speed	3. A. Loose flywheel cover B. Loose coupler C. Loose flywheel D. Drive plate E. Main bearing F. Rod bearing
4. Crankshaft area, throughout engine, timed to engine speed	4. A. Loss of oil pressure B. Main bearings C. Rod bearings

MISCELLANEOUS

NOISE	POSSIBLE CAUSE
1. Engine spark knock	1. A. Advanced timing B. Low octane fuel C. Engine running hot D. Carbon deposits in engine
2. Popping through carburetor	2. A. Wrong ignition timing B. Carburetor set too lean C. Faulty accelerator pump D. Vacuum leak E. Valve adjustment F. Valve timing G. Burned or stuck valve
3. Hissing	3. A. Vacuum leak B. Fuel pump (hissing in sight tube) C. Leaking exhaust (manifolds or pipes) D. Loose cylinder heads E. Blown head gasket
4. Whistle	4. A. Vacuum leak B. Dry or tight bearing in an accessory
5. Sparks jumping	5. A. Leaking high tension lead B. Cracked coil tower C. Cracked distributor cap
6. Squeaks or squeals	6. A. Drive belt slipping B. Dry or tight bearing in an accessory C. Parts rubbing together
7. Rattling in exhaust pipe area	7. A. Exhaust shutters

OIL PRESSURE

IMPORTANT INFORMATION

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure reading.

CAUSE	SPECIAL INFORMATION
1. Measuring oil pressure	1. Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
2. Check engine oil level with boat at rest in the water	2. Oil level should be between the "ADD" and "FULL" marks.
3. Oil level in crankcase above "FULL" mark	3. May cause loss of engine RPM, oil pressure gauge flucuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM.
4. Oil level in crankcase below "ADD" mark	4. Low oil pressure; oil pressure gauge flucuation; internal engine noise and/or damage.
5. Change in oil pressure	5. This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal operating temperature, it is normal for oil pressure to drop off slightly.
6. Low engine oil pressure at idle	6. With modern engines and engine oils, low oil pressure readings at idle does not necessarily mean there is a problem. If valve lifters do not "clatter" (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thin out somewhat from heat.
7. Low engine oil pressure at idle after running at a high RPM	7. Refer to "No. 5 and 6" preceding.
8. Boats with dual engines	8. It is not uncommon to see different oil pressure readings between the two engines, as long as both engines are within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
9. Boats with dual stations	9. Refer to "No. 8" preceding.

LOW OIL PRESSURE

NOTICE
Refer to "Section 1, Part B" for minimum oil pressure reading.

CAUSE	SPECIAL INFORMATION
1. Low oil level in crankcase	
2. Defective oil pressure gauge and/or sender	2. Verify reading with an automotive test gauge. Refer to "Section 4, Part D" for instrument testing.
3. Thin or diluted oil	3. Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation).
4. Oil pump	4. Relief valve stuck open; pick-up tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pick-up tube.
5. Oil leak - can be internal or external	5. Oil passage plugs leaking, cracked, or porous cylinder block.
6. Excessive bearing clearance	6. Cam bearings, main bearings, rod bearings.

HIGH OIL PRESSURE

CAUSE	SPECIAL INFORMATION
1. Oil too thick	1. Wrong viscosity, oil full of sludge or tar.
2. Defective oil pressure gauge and/or sender	2. Verify with an automotive test gauge. **IMPORTANT: Oil pressure, slightly higher than normal, does not always indicate a problem. Tolerance stackup in the engine, oil viscosity, and weather conditions could cause high oil pressure.**
3. Clogged or restricted oil passage	
4. Oil pump relief valve stuck closed	

EXCESSIVE OIL CONSUMPTION

CAUSE	SPECIAL INFORMATION
1. Normal consumption	1. One quart of oil consumed in 5-15 hours of operation at WOT (especially in a new or rebuilt engine) is normal.
2. Oil leaks	2. Clean bilge; run engine with clean white paper on bilge floor; locate oil leak(s).
3. Oil too thin	3. Oil diluted or wrong viscosity.
4. Oil level too high	
5. Drain holes in cylinder head plugged	5. Oil will flood valve guides.
6. Defective valve seals	
7. Intake manifold gasket leaking	
8. Worn valve stems or valve guides	
9. Defective oil cooler (if so equipped)	9. Crack in cooler tubes.
10. Defective piston rings	10. Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap.
11. Defective cylinders	11. Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston.
12. Excessive bearing clearance	

WATER IN ENGINE

IMPORTANT INFORMATION

IMPORTANT: First, determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons".

The first step, after locating water, is to remove all water from the engine by removing all spark plugs and pump cylinders out by cranking engine over. Next change oil and filter. Now, start engine and see if problem can be duplicated. If problem can be duplicated, there more than likely is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If water is located in both cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete engine submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered through these areas.

WATER ON TOP OF PISTONS

CAUSE	SPECIAL INFORMATION
1. Operator shut engine off at high RPM	
2. Engine "diesels" or trys to run backwards	2. Engine out of tune; poor fuel; high idle RPM; timing set too high.
3. Rain water running into flame arrestor	3. Hatch cover.
4. Spark plug misfiring	4. Improper combustion causes moisture in the air to accumulate in the cylinder.
5. Backwash through the exhaust system	
6. Improper engine or exhaust hose installation	6. Refer to Section 6, Part B for exhaust specifications.
7. Cracked exhaust manifold	
8. Improper manifold to elbow gasket installation	
9. Loose cylinder head bolts	
10. Blown cylinder head gasket	10. Check for warped cylinder head or cylinder block.
11. Cracked valve seat	
12. Porous or cracked casting	12. Check cylinder heads, cylinder block, and intake manifold.

WATER IN CRANKCASE OIL

CAUSE	SYMPTOM
1. Water in boat bilge	1. Boat has been submerged or bilge water was high enough to run in through dipstick tube.
2. Water seeping past piston rings or valves	2. Refer to "Water in Engine (On Top of Pistons)".
3. Engine running cold	3. Defective thermostat, missing thermostat; prolonged idling in cold water.
4. Intake manifold leaking near a water passage	
5. Cracked or porous casting	5. Check cylinder head, cylinder block, and intake manifold.

ENGINE OVERHEATS (MECHANICAL)

CAUSE	SPECIAL INFORMATION
1. Engine RPM below specification at WOT (engine laboring)	1. Damaged or wrong propeller; growth on boat bottom; false bottom full of water.
2. Wrong ignition timing	2. Timing too far advanced.
3. Sticking distributor advance weights	
4. Spark plug wires crossed (wrong firing order)	
5. Lean fuel mixture	5. Refer to "Carburetor Malfunctions", in this section.
6. Wrong heat range spark plugs	
7. Exhaust restriction	
8. Valve timing off	8. Timing gear improperly installed.
9. Blown head gasket	9. A blown head gasket normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM. Refer to Section 6, Part A.
10. Insufficient lubrication to moving parts of engine	10. Defective oil pump, plugged oil passage, low oil level.

ENGINE OVERHEATS (COOLING SYSTEM)

CAUSE	SPECIAL INFORMATION
IMPORTANT: The first step is to verify if the engine is actually overheating or if the temperature gauge or sender is faulty.	**IMPORTANT: Best way to test gauge or sender is to replace them.**
1. Loose or broken drive belt	
2. Seawater inlet hose kinked or collapsed	
3. Seawater pick-up clogged	
4. Obstruction on boat bottom causing water turbulence	4. Obstruction will be in front of seawater pick-up, causing air bubbles to be forced into cooling system.
5. Defective thermostat	
6. Exhaust elbow water outlet holes plugged	
7. Insufficient seawater pump operation	7. Worn pump impeller.
8. Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	8. Refer to water flow diagram for engine type being serviced.
9. Engine circulating pump defective	
10. Also refer to "ENGINE OVERHEATS (MECHANICAL)"	10. See "Index".
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
11. Low coolant level	
12. Anti-freeze not mixed properly	12. Anti-freeze should be mixed 50/50 or maximum 60/40. 60% anti-freeze, 40% water.
13. Heat exchanger cores plugged	
14. Water hoses reversed at the water distribution block	14. Refer to water flow diagrams Section 6, Part A.
15. For further testing of the closed cooling system	15. Refer to Section 6, Part A.

INSUFFICIENT WATER FLOW FROM DRIVE UNIT SEAWATER PICKUP PUMP

CAUSE	SPECIAL INFORMATION
1. Seawater shut-off valve partially or fully closed (if equipped)	
2. Water pickups clogged with foreign material	
3. Kinked or broken bell housing-to-gimbal housing water tube hose	
4. Corroded thru gimbal housing water tube	
5. Water pickup inserts warped. (Engine will overheat while boat is underway only.)	5. Pickup inserts must not protrude above gear housing surface or inserts will create an irregular or turbulent water flow over the water pickup holes. Consequently, this may cause loss of cooling water and subsequent engine overheating. This condition also can be identified by cavitation burn (pitting, erosion) on the gear housing in the area aft of the water pickup inserts.
6. Damaged gear housing or accessories improperly installed on boat bottom or transom (speedometer pickup, depth sounder transducer, etc.). Substantial amount of barnacles or other marine growth on gear housing or boat bottom. (Engine will overheat while underway only.)	6. An object or an irregularity on boat or gear housing in area close to water pickups could create turbulence in water flow going to water pickups. This could aerate the water flow and cause engine to overheat.
7. Stern drive installed too high on transom or drive unit trimmed too far out allowing air to be drawn into pump. (Engine will overheat while underway only.)	7. Contact boat company if stern drive is installed too high. Instruct operator on proper trimming technique if unit is trimmed out too far.
8. Bell housing-to-drive shaft housing "O" ring missing or damaged	
9. Faulty seawater pickup pump	
10. Seawater pickup pump water tube corroded thru	
11. Drive shaft housing water pocket cover cracked	
12. Broken-off impeller blade or other obstruction in water passages (usually lodges in drive shaft housing water pocket cover or cross-drilled water passage).	12. To check cross-drilled water passage in drive shaft housing, remove welch plug and pipe plug located under decal on starboard side of housing. Drive unit must be shifted into reverse to remove pipe plug.
13. Water passage in drive shaft housing improperly drilled	

POWER STEERING

POOR, ERRATIC OR NO ASSIST

CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Broken or out of adjustment.
2. Low fluid level	
3. Air in system	3. Air leak in lines, pump, or air from installation. Refer to Section 7 for bleeding procedure.
4. Leaking hoses	4. Refer to Section 7 for bleeding procedure.
5. Steering cable and/or steering helm	5. Cable or helm partially froze from corrosion or rust; cable over lubricated; improper cable installation.
6. Binding in stern drive unit	6. Refer to appropriate "Stern Drive Service Manual".
7. Restriction in hydraulic hoses	7. Causes a loss of pressure.
8. Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
9. Mounting bracket adjusting screw loose or mounting tube is loose	
10. Faulty pump	10. Flow control valve may be sticking.
11. Worn piston ring or scored housing bore in cylinder	11. Causes loss of pressure.
12. Leaking valve body or loose fitting spool	

NOISY PUMP

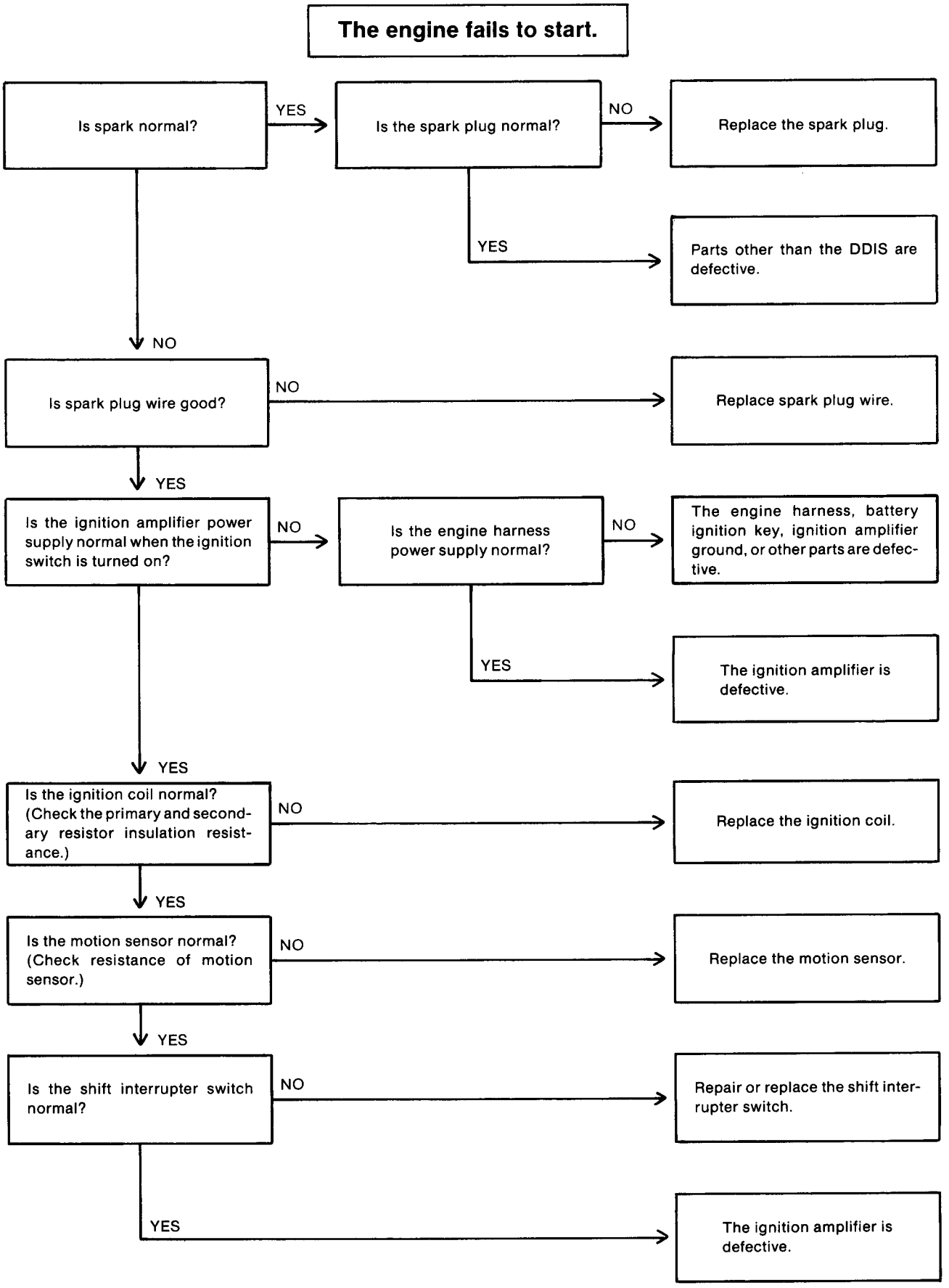
CAUSE	SPECIAL INFORMATION
1. Drive belt	1. Check tension.
2. Low fluid level	
3. Air in fluid	3. Air leak in lines, pump, or air from installation. Refer to Section 7 for bleeding procedure.
4. Faulty pump	4. Use stethoscope to listen for noise in the pump.
5. Restricted fluid passages	5. Kinks or debris in hoses or debris in passages.
6. Stop nut adjusted improperly	6. Refer to appropriate "Stern Drive Service Manual".
7. Steering cables used do not meet BIA standards	7. Refer to appropriate "Stern Drive Service Manual".

FLUID LEAKS

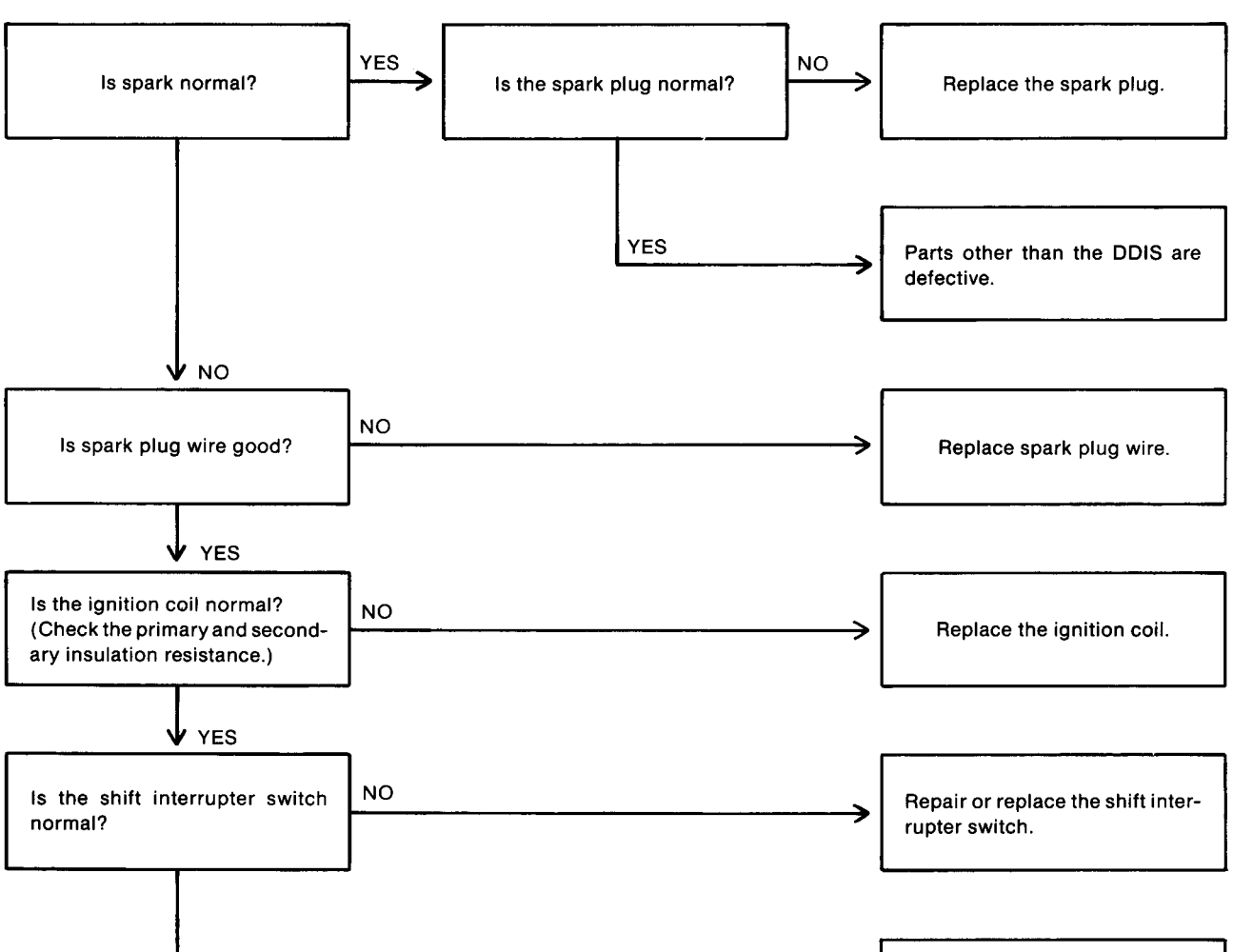
CAUSE	SPECIAL INFORMATION
1. Loose hose connections	1. Refer to Section 7 for bleeding procedure.
2. Damaged hose	
3. Oil leaking from top of pump	3. System overfilled; fluid contains water; fluid contains air.
4. Cylinder piston rod seal	
5. Faulty seals in valve	
6. Faulty seals or "O" rings in pump	
7. Cracked or porous metal parts	

Digital Distributorless Ignition System (DDIS)

Troubleshooting



The engine fails to idle.



REMOVAL and INSTALLATION

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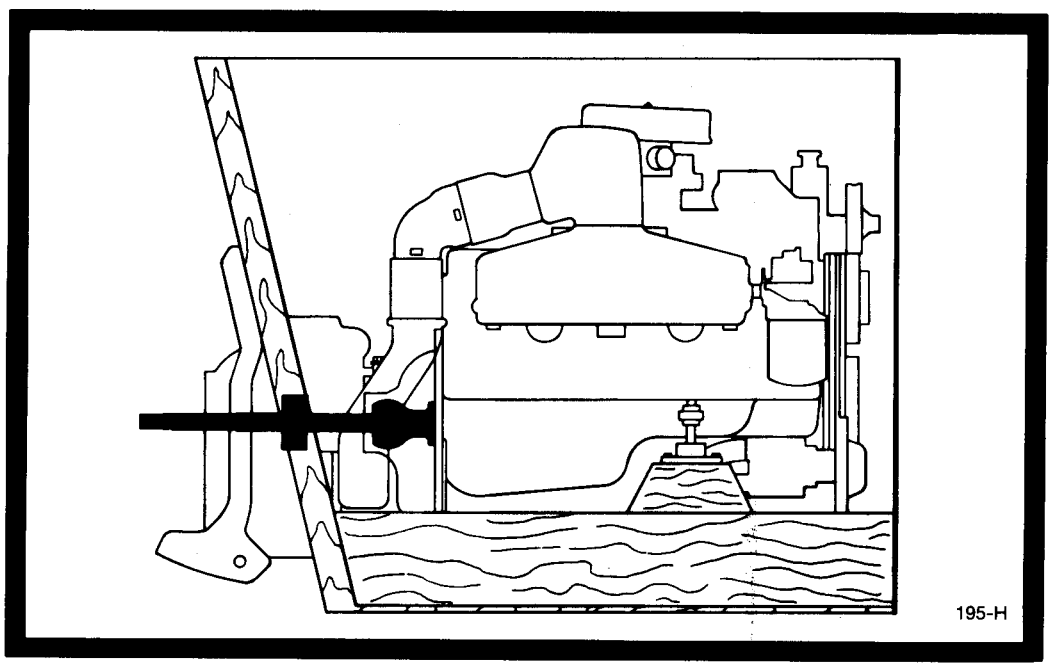

4 CYL 153 - 181 CID (2.5 - 3.0L)

mercruiser
STERN DRIVES & INBOARDS

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Torque Specifications

NOTE: Listed Below Are the Torque Specifications for Those Fasteners Which Have a Specific Torque Value. Tighten All Other Fasteners (Not Listed) Securely.

Description	Torque Value
Exhaust Pipe to Gimbal Housing Screws	20-25 lbs. ft. (27-34 N.m)
Rear Engine Mount Bolts/Nuts	35-40 lbs. ft. (47-54 N.m)
Power Trim Cylinders to Anchor Pin Nuts	Tighten until they bottom out.
Propeller Nut	55 lbs. ft. (75 N.m) MINIMUM
Shift Cable End Guide Attaching Nuts	Tighten each nut until it bottoms out against flat washer, then back-off 1/2 turn.
Fuel Line Inlet Fitting	110 lbs. in. 12.5 N·m)
Steering Cable Coupler Nut	35 lbs. ft. (48 N.m)
Steering Cable Coupler Nut Locking Plate Screw (If Equipped with Optional Power Steering)	65 lbs. in. (7.2 N·m)
Steering System Pivot Bolts	25 lbs. ft. (34 N.m)
Stern Drive Unit to Bell Housing Attaching Nuts	50 lbs. ft. (68 N.m)
Transom Assembly Attaching Screws and Nuts	20-25 lbs. ft. (27-34 N.m)
Power Steering Hydraulic Hose Fittings — Large	20-25 lbs. ft. (27-34 N.m)
— Small	96-108 lbs. in. (10.8 - 12.2 N.m)

Lubricants

92-825407A2	Quicksilver 2-4-C Marine Lubricant
92-816391-A4	Engine Coupler Spline Grease

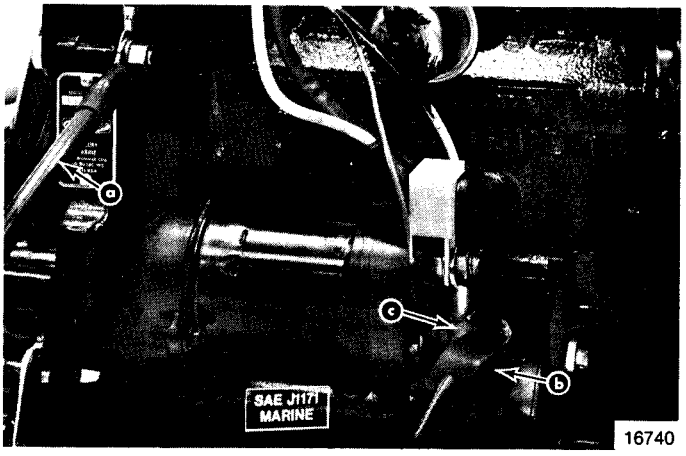
Tools

91-805475A1	Engine Alignment Tool

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables at battery.
2. Disconnect battery cables from engine and starter.



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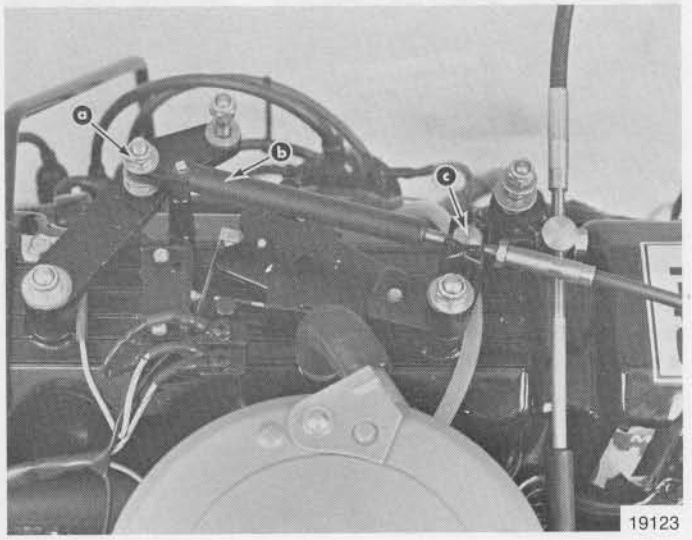
a - Negative (-) Battery Cable
b - Rubber Boot (Slid Back from Terminal)
c - Positive (+) Battery Cable

3. Disconnect and cap fuel inlet line from fuel pump.

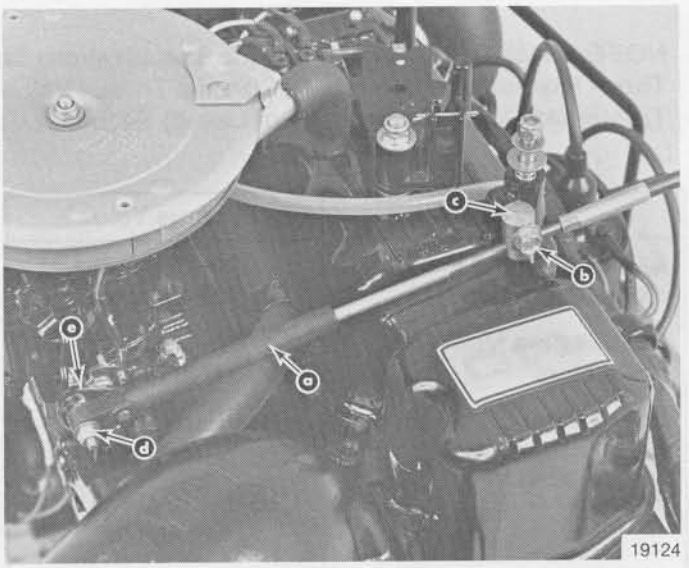
a - Fuel Pump
b - Disconnect Fuel Inlet Line Here

4. Disconnect shift cables.



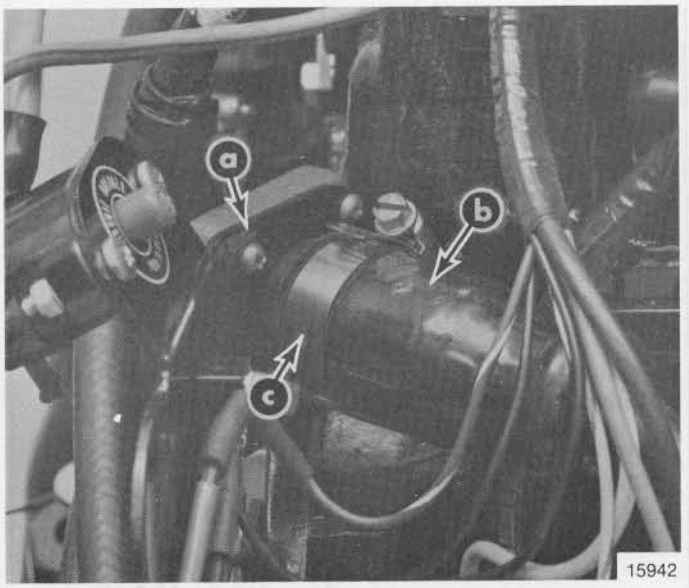
a - Locking Nut
b - Shift Cable End
c - Cotter Pin

5. Disconnect throttle cable.



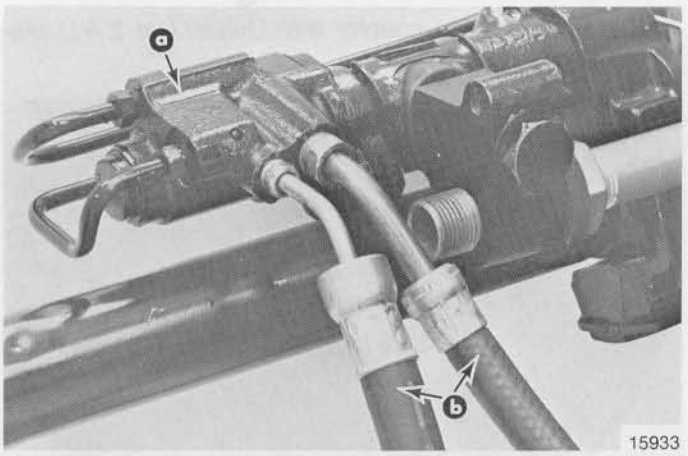
a - Cable End Guide
b - Throttle Cable Anchor Screw
c - Brass Barrel
d - Elastic Stop Nut and Flat Washer
e - Throttle Lever

6. Loosen clamp and unplug wiring harness.



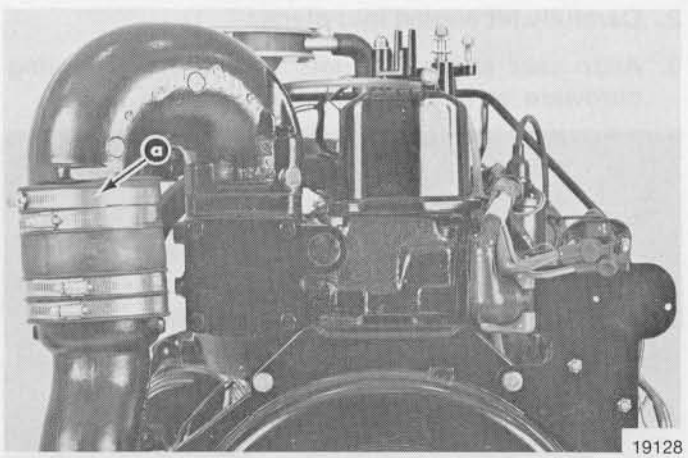
a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp

7. Disconnect and cap power steering hoses.



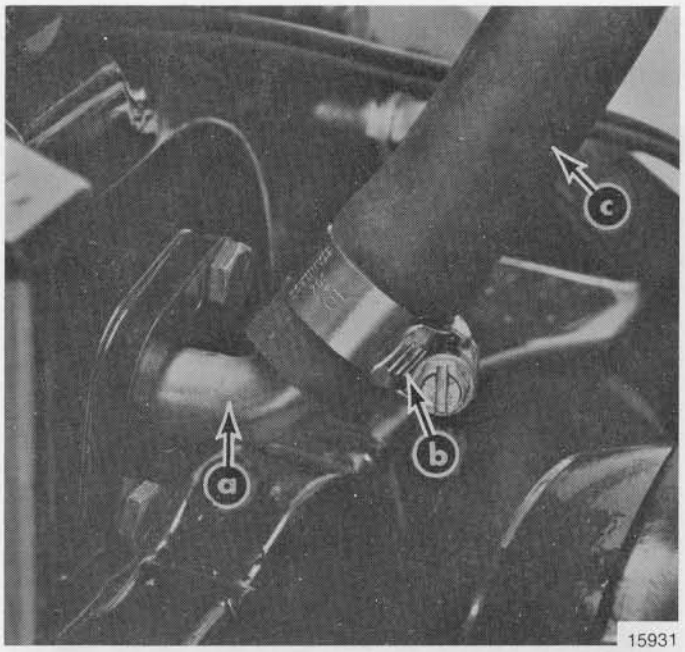
a - Power Steering Control Valve
b - Power Steering Hoses

8. Loosen hose clamps and remove bellows from upper exhaust pipe.



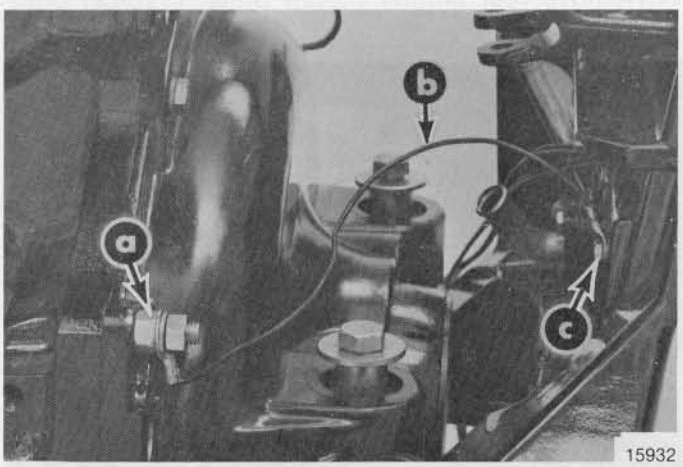
a - Hose Clamps (Loosen and Remove Exhaust Pipe Assembly from this Location)

9. Loosen hose clamp and remove water inlet hose from water tube.



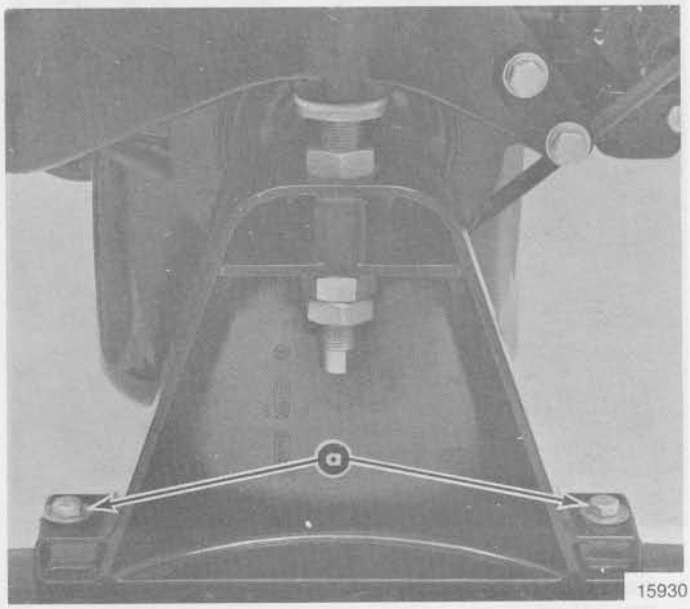
a - Water Tube
b - Hose Clamp (Tighten Securely)
c - Water Hose

10. Disconnect ground wire from ground stud.



a - Flywheel Housing Attaching Screw and Grounding Stud
b - Ground Wire
c - Inner Trnasom Plate Grounding Screw

11. Disconnect power trim position sender wires and any other wires connected to engine.
12. Attach a suitable lifting sling to lifting eyes.
13. Remove front mount retaining screws.



a - 3/8" (10mm) Diameter Lag Bolts

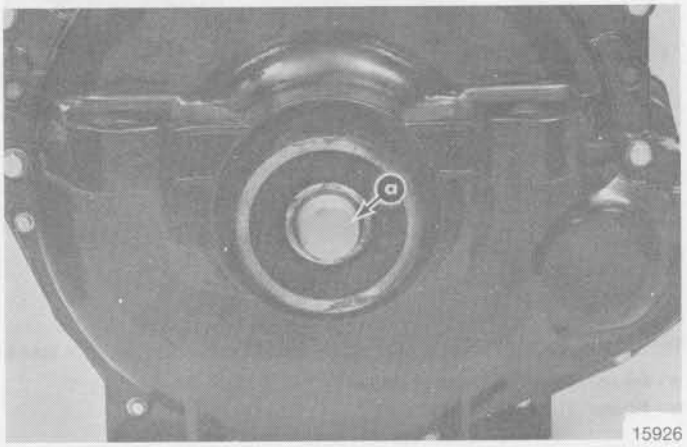
14. Remove rear engine mount bolts. (Typical both sides)

a - Rear Engine Mount Bolt

15. Remove engine.

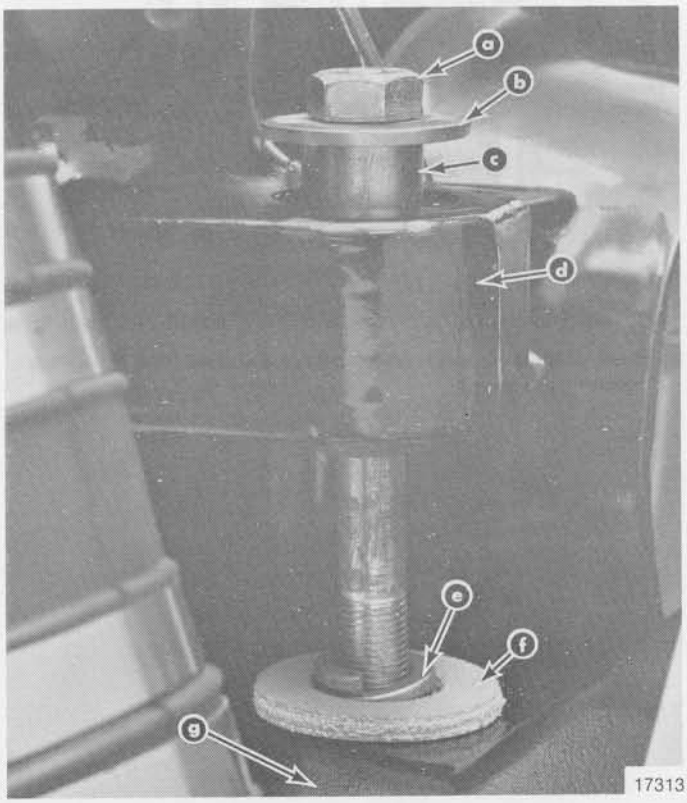
Installation and Alignment

1. Lubricate engine coupler with Quicksilver 2-4-C Marine Lubricant.



a - Remove Shipping Plug and Lubricate Splines with Quicksilver 2-4-C Marine Lubricant

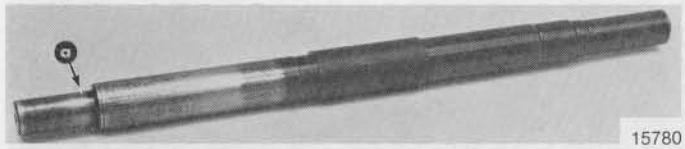
2. Carefully lift engine into place.
3. Align rear engine mounts and install mounting hardware, as shown.



a - Rear Engine Mounting Bolts [Torque Both Bolts to 35-40 Lbs. Ft. (47-54 N.m)]
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lcokwasher
f - Fiber Washer
g - Inner Transom Plate Engine Support

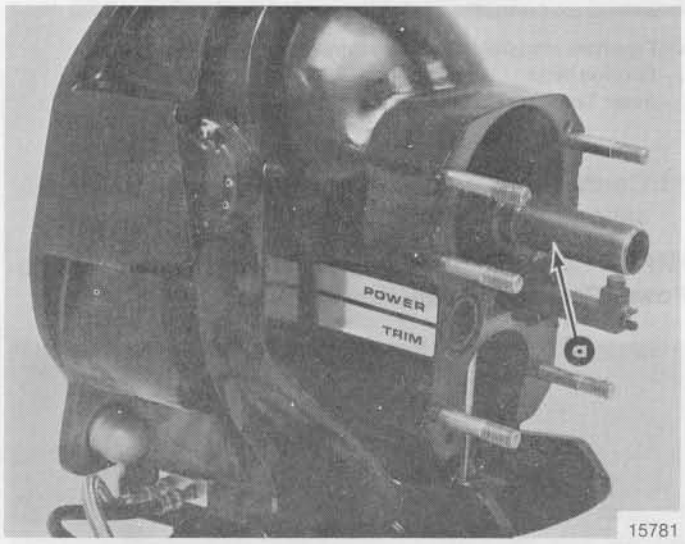
IMPORTANT: Do not relieve hoist tension entirely.

4. Torque rear mount bolts to specifications.
5. Install alignment tool thru gimbal housing and into engine coupler as shown.



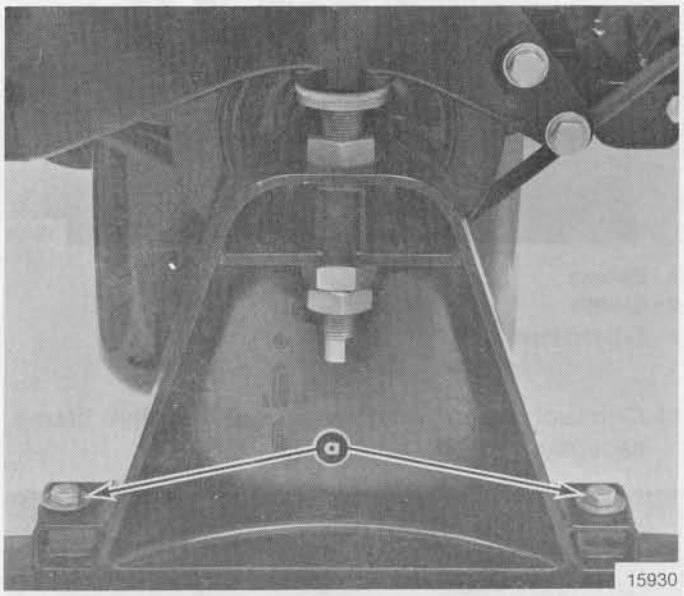
a - Insert This End of Alignment Tool thru Gimbal Housing Assembly

Alignment Tool (91-805475A1)



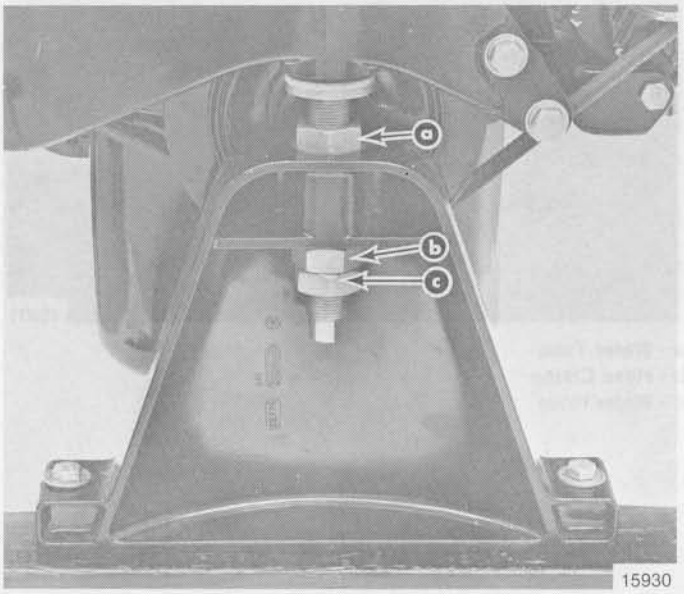
a - Alignment Tool

6. Raise or lower front of engine with hoist as required to allow alignment tool to slide freely all the way into engine coupler.
7. Adjust front mount to rest on stringer while supporting engine and maintaining free movement with alignment tool.
8. Secure mount base to stringer with lag bolts.



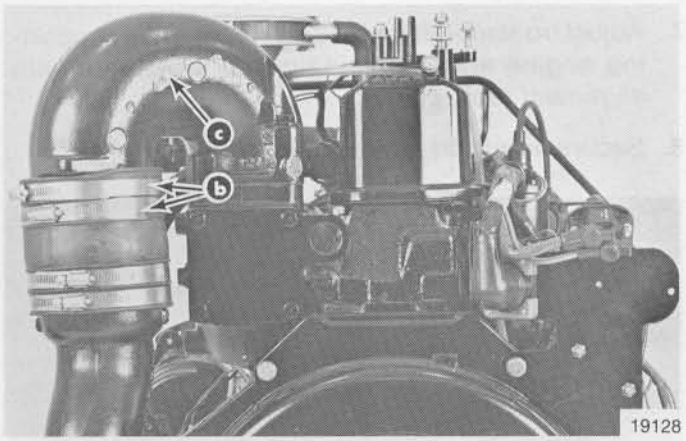
a - 3/8" (10mm) Diameter Lag Bolts of Sufficient Length and Flat Washers

9. Tighten adjusting nut, locknut and jamnut.



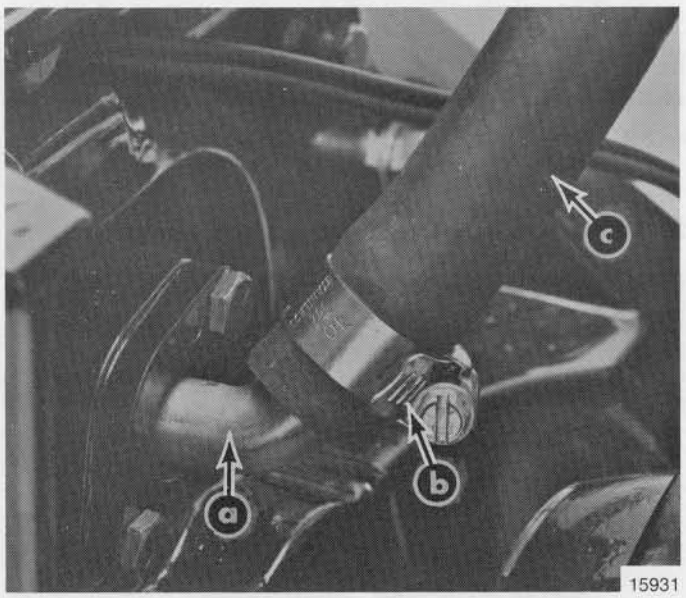
a - Adjusting Nut
b - Locknut
c - Jamnut

10. Connect bellows to exhaust pipe and tighten clamps securely.



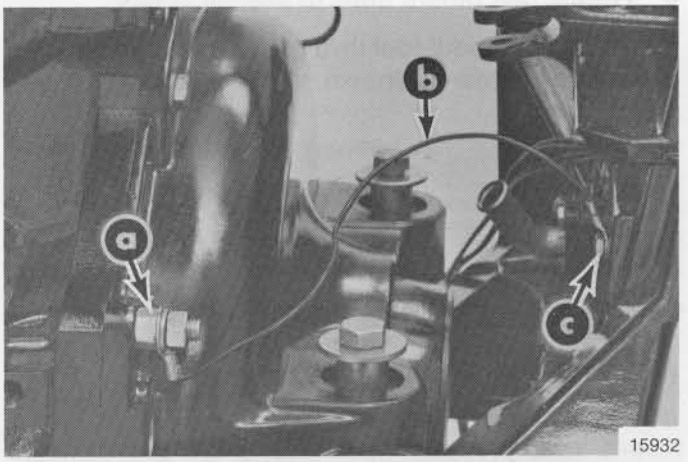
a - Bellows
b - Clamps
c - Exhaust Pipe

11. Connect water inlet hose and tighten clamp securely.



a - Water Tube
b - Hose Clamp
c - Water Hose

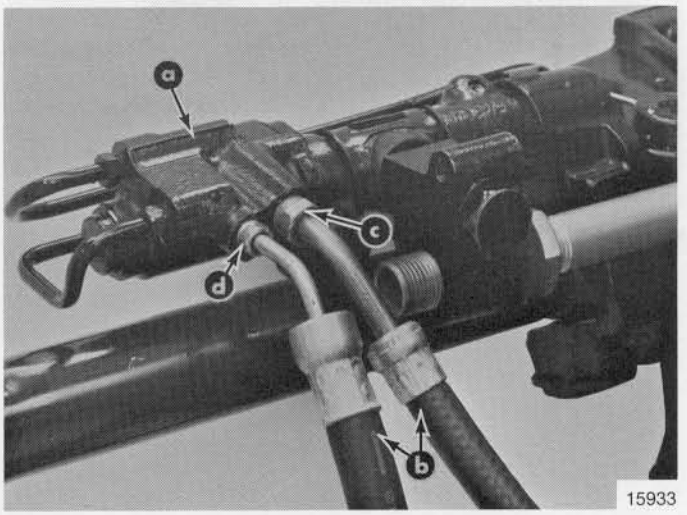
12. Attach engine ground wire to grounding stud.



a - Flywheel Housing Attaching Screw and Grounding Stud
b - Ground Wire
c - Inner Transom Plate Grounding Screw

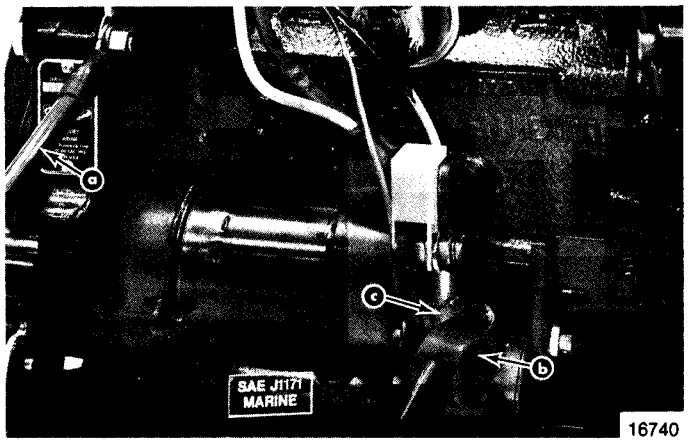
13. Connect power steering hoses. Tighten to specifications.

IMPORTANT: To bleed power steering system refer to Power Package Installation Manual.



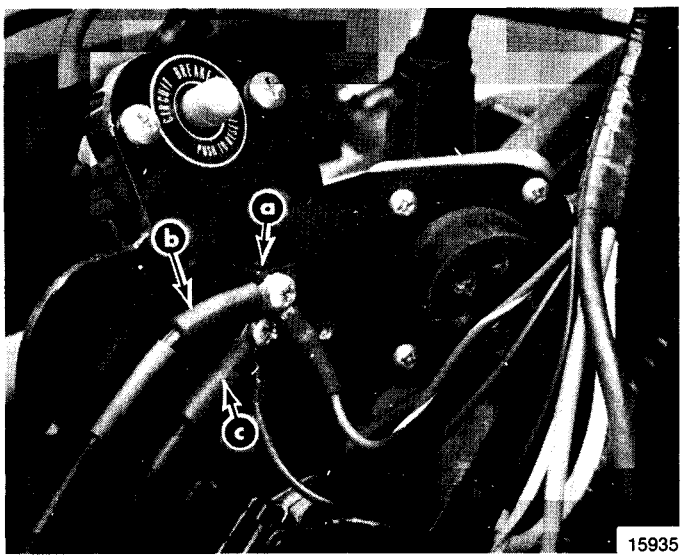
a - Power Steering Control Valve
b - Hydraulic Hoses
c - Torque Large Fitting to 20-25 Lbs. Ft. (27-34 N.m). DO NOT OVER-TIGHTEN.
d - Torque Small Fitting to 96-108 Lbs. In. (10.8-12.2 N.m). DO NOT OVER-TIGHTEN.

14. Connect battery cables to engine and starter, tighten securely.



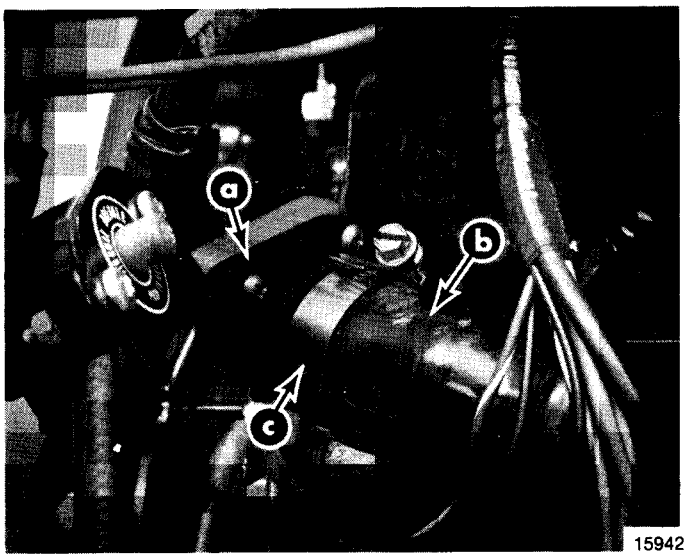
a - Negative (-) Battery Cable
b - Rubber Boot (Slid Back from Terminal)
c - Positive (+) Battery Cable

15. Connect trim limit switch leads as shown.



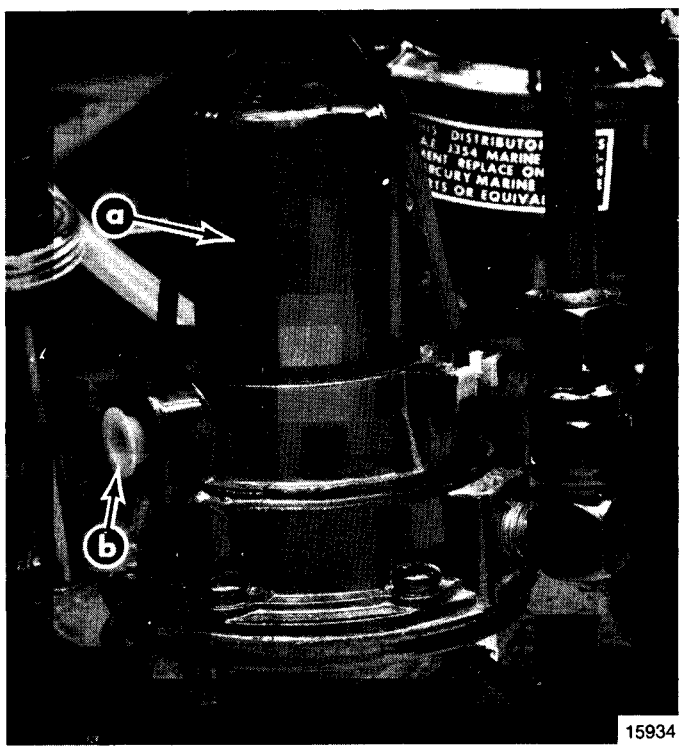
a - Terminal Block
b - Connect Trim Position Sender Lead with Brown or Purple Sleeve to Terminal Which Brown/White Lead Is Already Attached
c - Connect Trim Position Sender Lead without Sleeve to Terminal Block Mounting Screw

16. Connect wiring harness as shown and tighten clamp securely.



a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp (Supplied with Harness)

17. Connect fuel line to fuel pump inlet and torque to specifications.

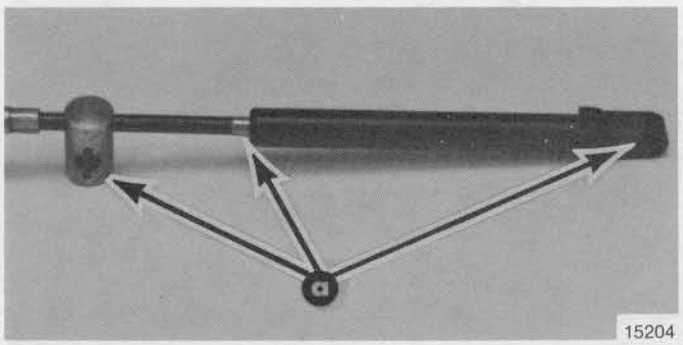


a - Fuel Pump
b - Remove shipping Plug and Connect Flexible Fuel Line Here

18. Connect any previously removed wiring.

Attaching and Adjusting Throttle Cable

1. Lubricate cable ends (shift and throttle) with Quicksilver 2-4-C Marine Lubricant at locations shown.



a - Lubricate Here

⚠CAUTION

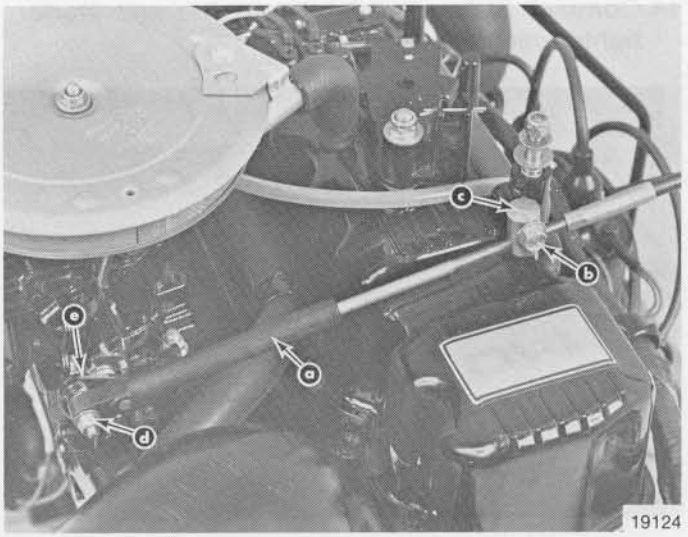
Throttle cable brass barrel must be adjusted properly. Over-adjusting barrel in the other direction will not allow throttle lever to return to idle position. Over-adjusting barrel in the other direction will exert excessive pressure on throttle lever which could cause damage to carburetor.

2. Place remote control handle in neutral.
3. Place cable end guide onto throttle lever stud and secure with flatwasher and elastic stop nut.

IMPORTANT: Do not tighten at this time.

4. Grasp cable behind brass barrel and push lightly toward throttle lever, adjust barrel to align with rocker cover attaching boss.

IMPORTANT: Brass barrel must position throttle cable so that cable is routed below the anchor screw.



a - Cable End Guide
b - Throttle Cable Anchor Screw
c - Brass Barrel
d - Elastic Stop Nut and Flat Washer
e - Throttle Lever

5. Tighten elastic stop nut on cable end guide, then back off 1/2 turn.

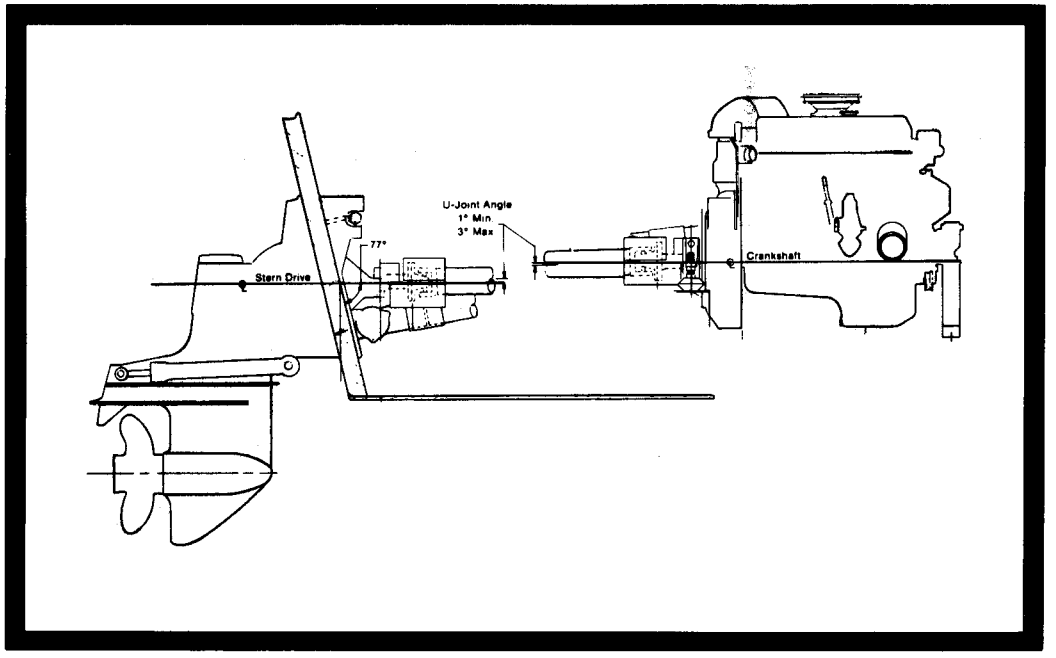
Attaching and Adjusting Shift Cable

For installation of Drive Unit and Shift Linkage, refer to appropriate Stern Drive Service Manual.

REMOVAL and INSTALLATION

2

B



DRIVESHAFT EXTENSION MODELS

mercruiser
STERN DRIVES & INBOARDS

INDEX

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Bearing Support Installation	2B-4
Alignment	2B-5
Attaching/Adjusting Throttle Cable	2B-9

TORQUE SPECIFICATIONS

Fastener Location	Lbs. Ft. (N.m)
Battery Cables	Securely
Bearing Support to Inner Transom Plate	50 (68)
Drive Shaft	50 (68)
Drive Shaft Shield	30 (41)
Extension Housing to Flywheel Housing	30 (41)
Flywheel Housing	30 (41)
Front and Rear Engine Mounts	Securely
Hose Clamps	Securely
Rear Engine Mount Bracket	50 (68)
Remote Control Throttle Cable Brass Barrel	Securely
Cable End Guide	(Note 1)

NOTE 1: Tight, then back nut off 1/2 turn.

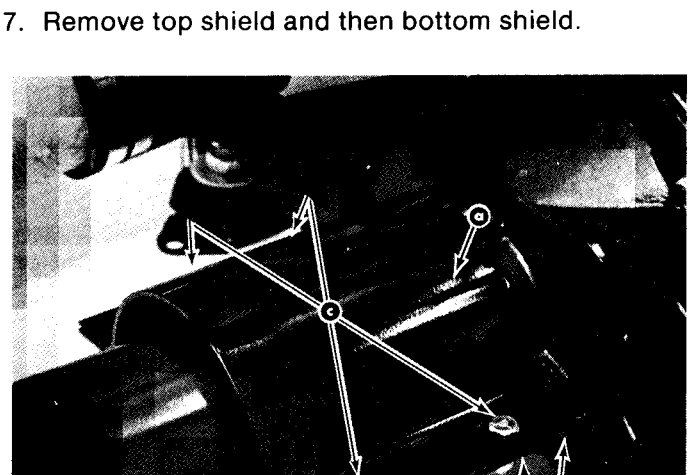
TOOLS/LUBRICANTS

TOOLS / LUBRICANTS	
91-805475A1	Engine Alignment Tool
92-825407A2	Quicksilver 2-4-C Marine Lubricant
92-816391A4	Engine Coupler Spline Grease
9-GT-3984	Sears Craftsman Universal Protractor

Removal

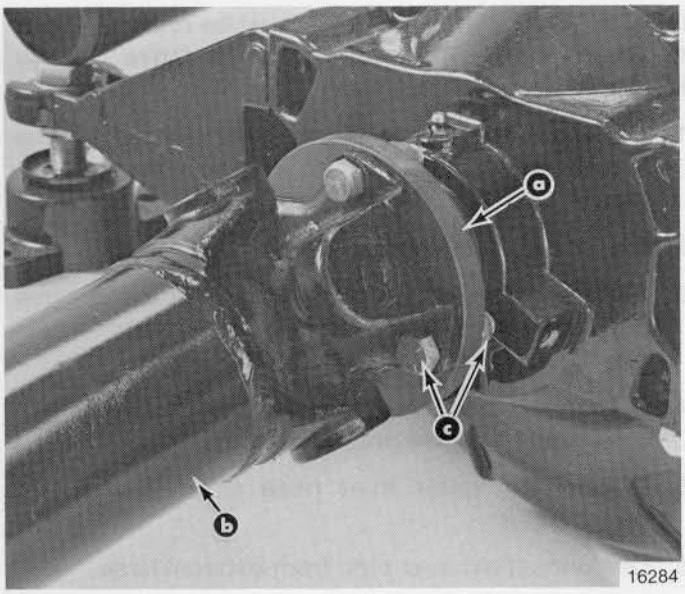
IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to "Stern Drive Service Manual".

1. Disconnect battery cables from battery and remove instrument harness plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable.
3. Slide sleeves back on black and white/green wires and disconnect engine harness wires from shift cut-out switch harness.
4. Disconnect brown/white wire from terminal block (on engine harness plug bracket).
5. Disconnect water inlet hose (from thermostat housing).
6. Disconnect exhaust pipe from exhaust hose.
7. Remove top shield and then bottom shield.



a - Top Shield
b - Bottom Shield
c - 4 Screws/Nuts (2 Hidden)
d - 3 Screws (Hidden)

8. Disconnect drive shaft from output flange.

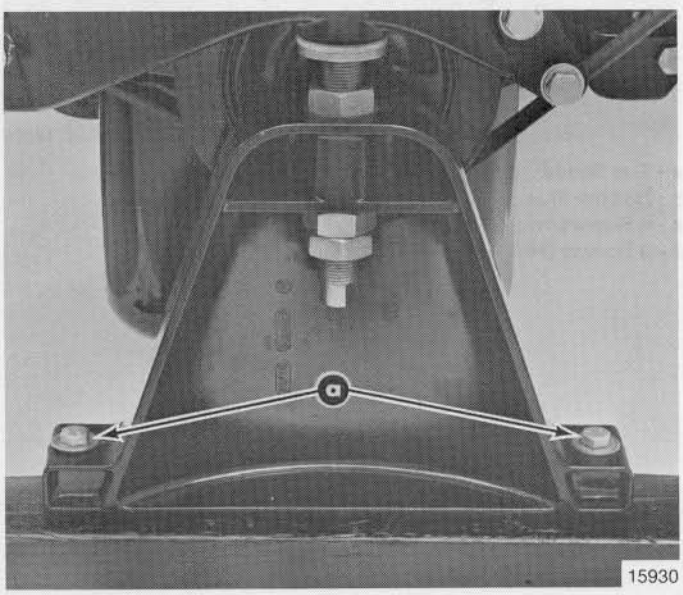


a - Output Flange
b - Drive Shaft
c - Screw/Nut (4)

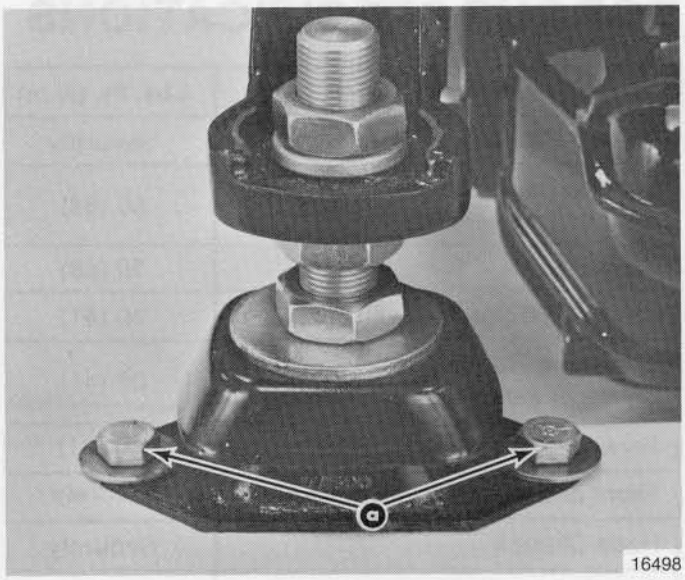
9. Disconnect any grounding wire or accessories that are connected to the engine.

IMPORTANT: To avoid the need for a complete realignment (after engine repair), do not move front or rear mounts. Remove mounting bolts as shown.

10. Support engine with suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts as shown.



a - Mounting Bolts



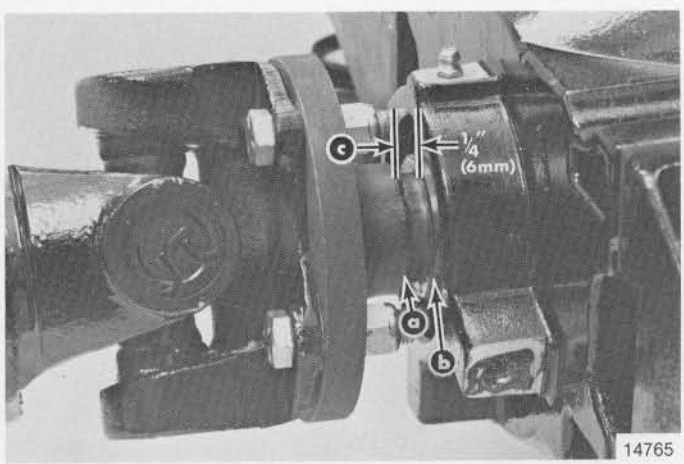
a - Mounting Bolts

Installation

IMPORTANT: If engine mounts or drive shaft have been changed, refer to "Alignment" before starting installation.

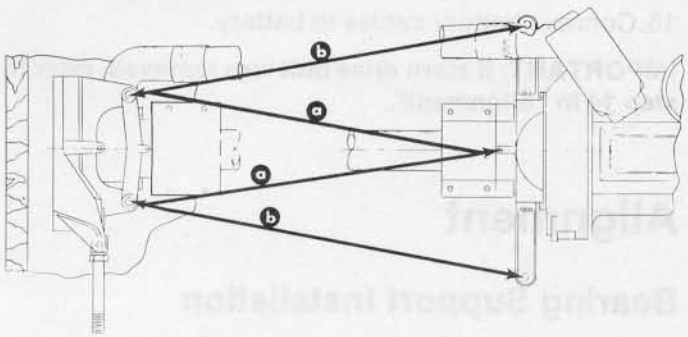
1. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
2. Set engine on stringers.
3. Connect drive shaft to output flange. Torque screws and nuts to specifications.
4. Relieve hoist tension from engine; then, slide engine fore or aft as needed to obtain a 1/4" (6mm) between flange shoulder and extension shaft housing bearing.

IMPORTANT: Failure to properly position output shaft flange (as described following) may result in bearing damage.



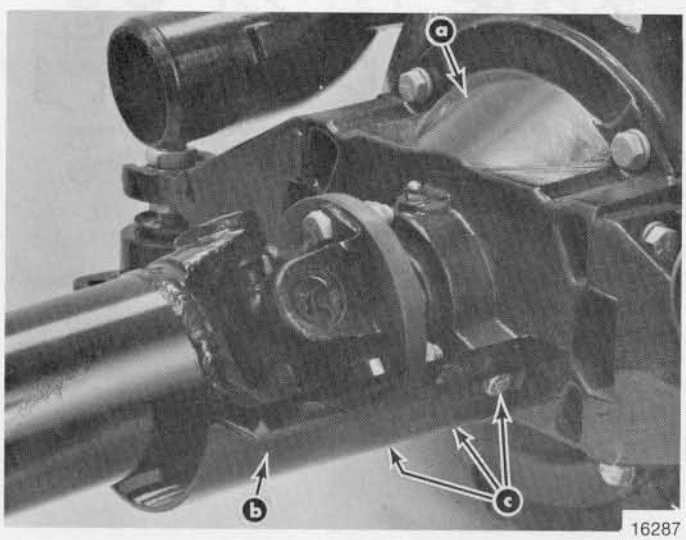
a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

5. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt, as shown. These distances must be equal. If not, slide front of engine to one side or the other until distances are equal.

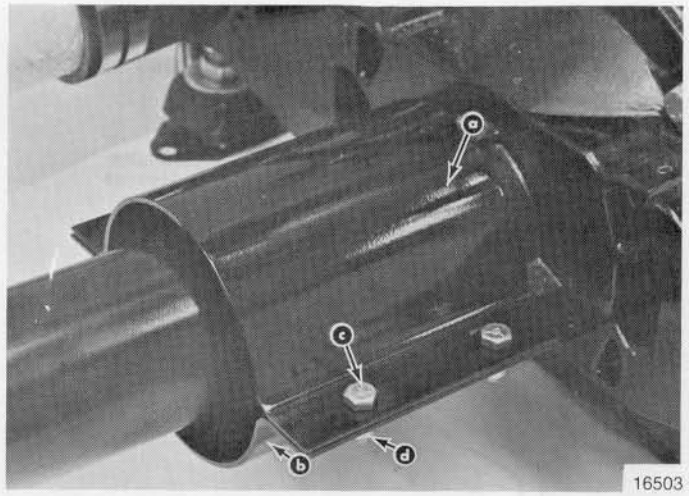


a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

6. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
7. Install top and bottom shield. Torque screws to specifications.

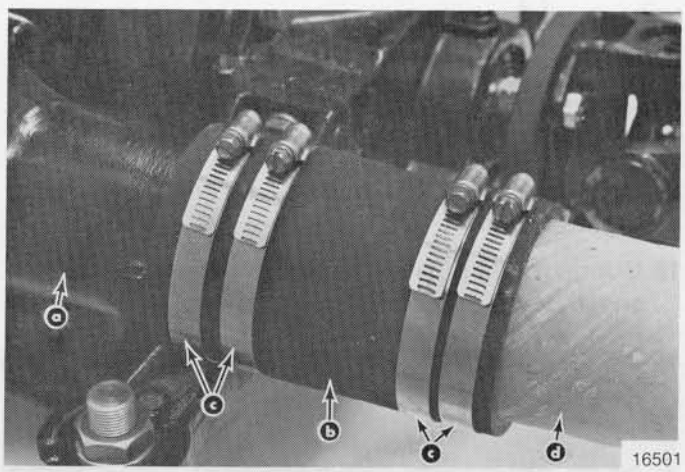


a - Shaft Housing
b - Bottom Shield
c - Screws (Threads of Screws are Coated with Loctite)



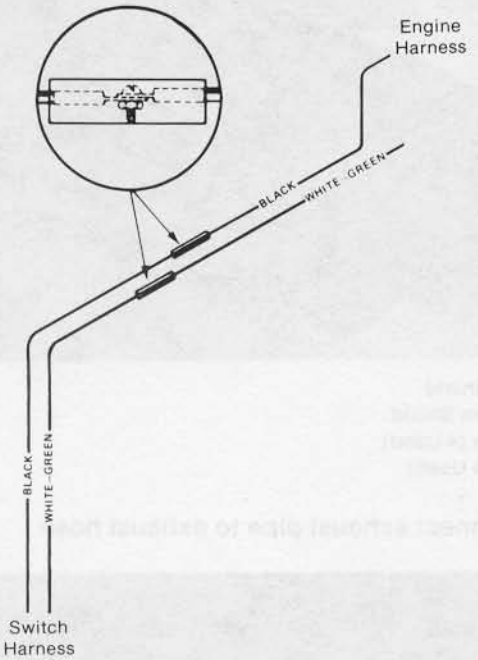
a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used)

8. Connect exhaust pipe to exhaust hose.

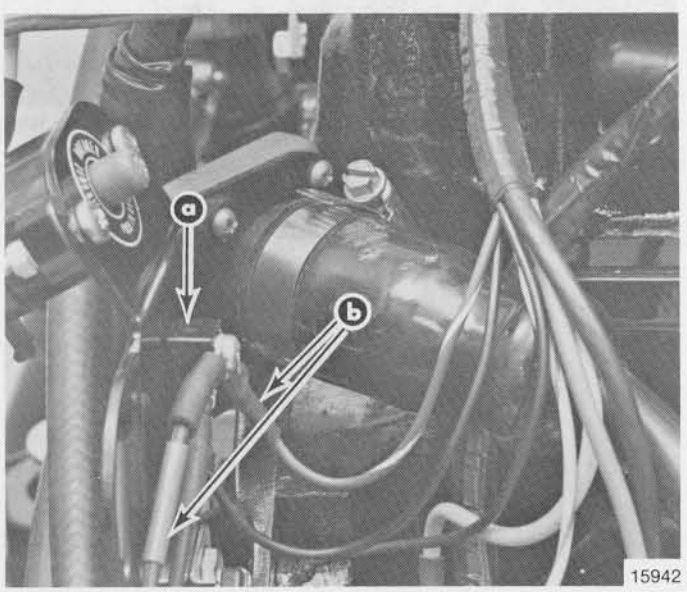


a - Exhaust Pipe
b - Exhaust Hose
c - Clamps (Tighten Securely)
d - Exhaust Tube

9. Connect water inlet hose to thermostat housing.
10. Reconnect shift cut-out switch harness to engine harness.



11. Connect instrument harness to engine harness. Tighten clamp.
12. Connect trim position sender brown/white wire as shown.



a - Terminal Block
b - Brown/White Wires

13. Connect fuel line. Check for leaks.
14. Connect throttle cable. Refer to "Attaching/Adjusting Throttle Cable".
15. Connect any grounding wires or accessories that may have been disconnected.
16. Connect battery cables to battery.

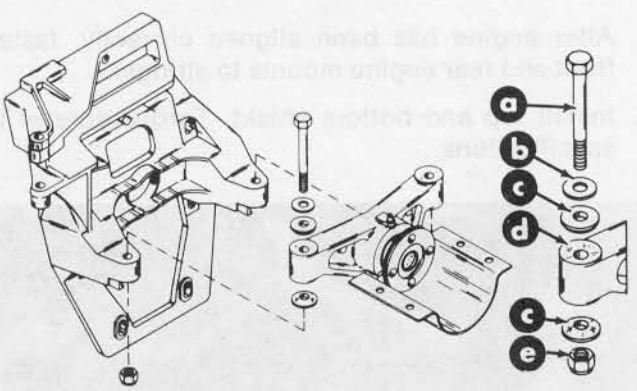
IMPORTANT: If stern drive unit was removed, refer to step 14 in "Alignment".

Alignment

Bearing Support Installation

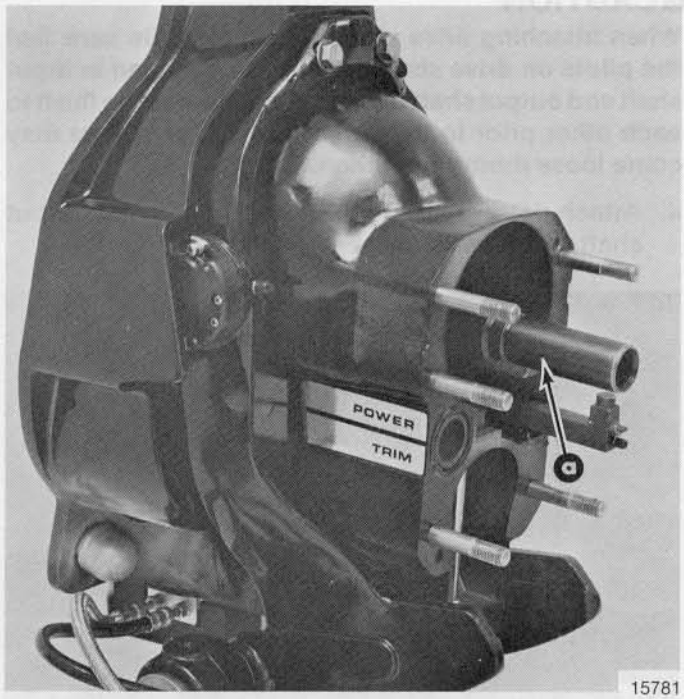
The following procedure must be used when installing bearing support on MCM 120/140 Models:

1. Install bearing support, as shown. Do not tighten bolts.



a - Bolt (2)
b - Flat Washer (2)
c - Spherical Washer (4) (Install with Rounded Side Toward Bearing Support)
d - Bearing Support
e - Nut (2)

2. Insert solid end of Alignment Tool (91-57797A3) thru bearing in gimbal housing and into input shaft splines.



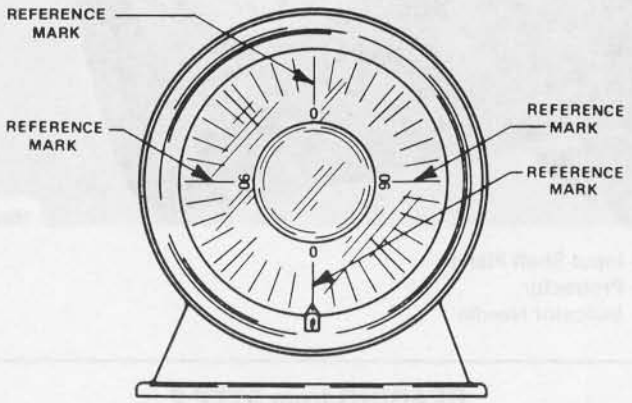
a - Alignment Shaft

3. Tighten bearing support bolts until snug [5-10 lbs. ft. (7-13 N.m)]. Strike the head of both bolts with a ball peen hammer, then torque bolts to specifications.

IMPORTANT: Bearing support attaching bolts must be struck with a hammer to properly seat spherical washers. If procedure is not followed, difficulty in installing stern drive unit may result and subsequent damage to bearings may occur from misalignment.

Alignment

IMPORTANT: A Sears Craftsman Universal Protractor (stock number 9-GT 3984) or equivalent is required for measuring the angles in the following steps. Protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0° and the 90° marks will be used. It should be kept in mind that these are reference marks only and the actual numbers should be ignored. It is only necessary to note the number of degrees and to which side (left or right) of the reference marks the indicator needle rests. Protractor must be viewed from the same side of power package throughout alignment.

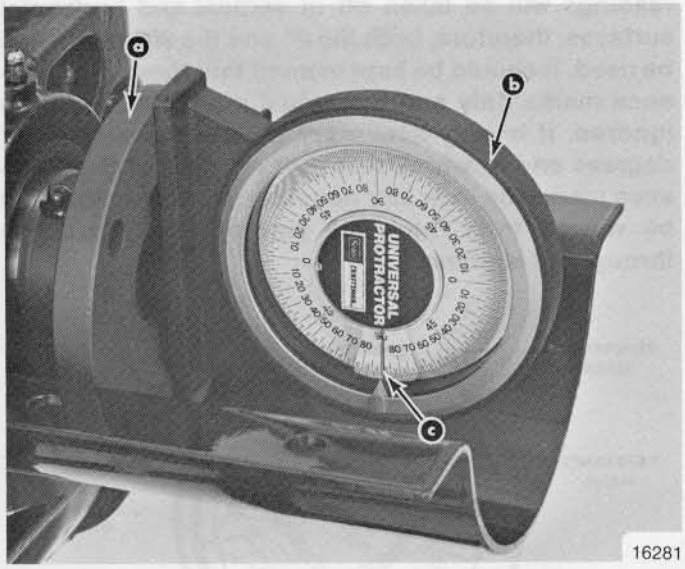


a - Reference Mark

1. Insert solid end of alignment tool thru bearing in gimbal housing and into bearing support input shaft splines.

a - Alignment Shaft

2. Position base of protractor against input shaft flange, as shown. Note and record the number of degrees and to which side of the reference mark the indicator needle has moved in the chart following.



a - Input Shaft Flange
b - Protractor
c - Indicator Needle

READING from STEP 2
_____ degrees to the
_____ side of Reference mark.

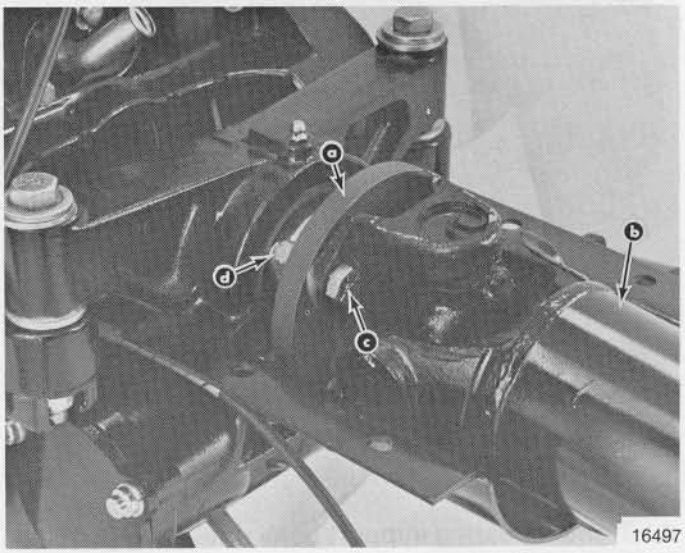
IMPORTANT: Be sure that boat does not move once reading has been taken from input shaft flange, as this reading establishes reference point for aligning drive shaft and engine following.

3. Lift engine into boat, using an overhead hoist and a chain (attached to lifting eyes on engine).

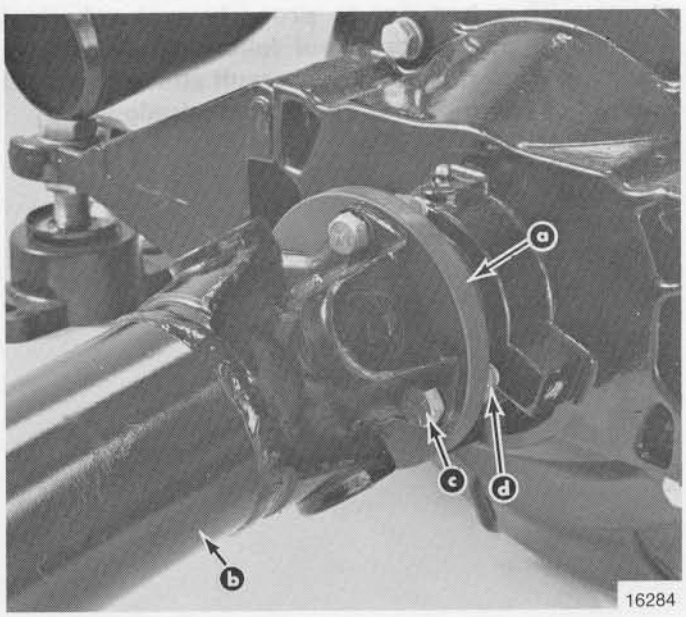
⚠CAUTION

When attaching drive shaft in next step. Be sure that the pilots on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges must be flush to each other prior to tightening screws, or screws may come loose during operation.

4. Attach drive shaft to input shaft flange and output shaft flange, as shown.

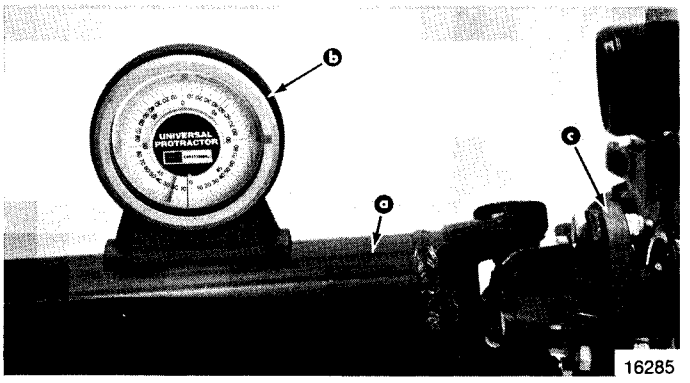


a - Input Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)



a - Output Shaft Flange
b - Drive Shaft
c - Screw (4 Used) (Torque to Specifications)
d - Nut (4 Used)

5. Position base of protractor on drive shaft; then, adjust engine mounts so that indicator needle is 1° to 3° on either side of reading taken in Step 2. Record this reading in the following chart for later use.



a - Drive Shaft
b - Protractor
c - Output Shaft Flange

READING from STEP 5

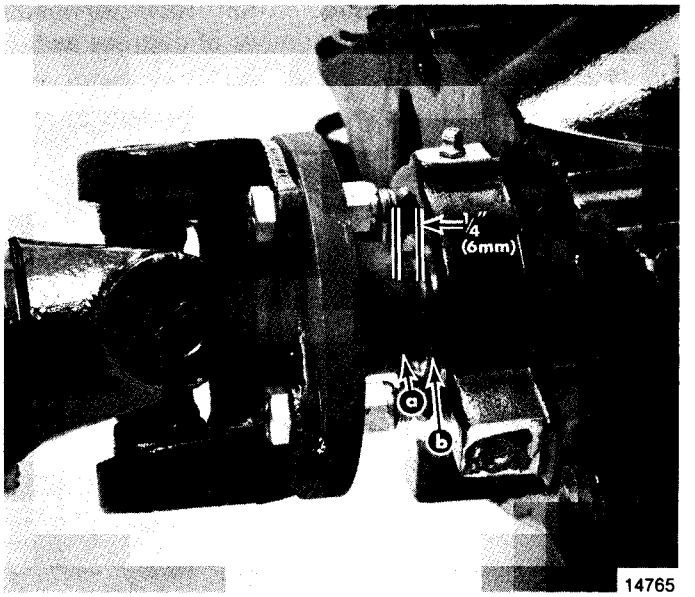
_____ degrees to the

_____ side of Reference mark.

IMPORTANT: A minimum of 1/4" (6mm) up-and-down engine mount adjustment must exist after engine has been properly aligned. This is necessary to allow for realignment of the engine in the future. If mount travel is insufficient, boat stringer height must be adjusted.

IMPORTANT: Failure to properly position engine (as described following) may result in bearing damage.

6. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain a 1/4" (6mm) between flange should and extension shaft housing bearing, as shown.

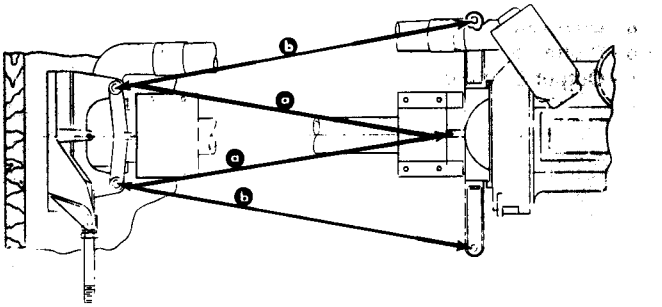


a - Flange Shoulder
b - Bearing
c - 1/4" (6mm)

⚠CAUTION

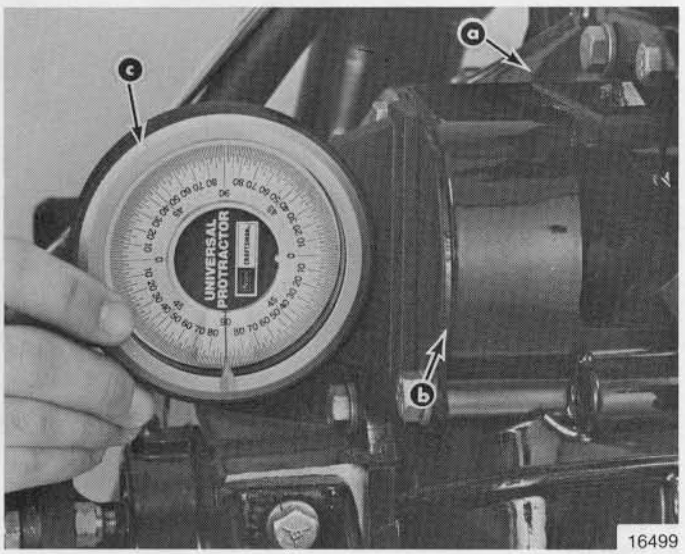
Engine must be aligned correctly to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at an incorrect angle, damage to universal joint bearings may result.

7. Position engine for correct engine and drive shaft lateral alignment as follows:
   a. The distance between the center of the bearing support attaching bolts (on inner transom plate) and grease fitting on shaft extension housing must be equal. If not, slide aft end of engine to one side or the other until distances are equal.
   b. Measure distance between the center of the bearing support attaching bolts and rear engine mount adjusting bolt, as shown. These distances also, must be equal. If not, slide front of engine to one side or the other until distances are equal.



a - Distance Between Bearing Support Attaching Bolts and Grease Fitting
b - Distance Between Bearing Support Attaching Bolts and Engine Mount Bolts

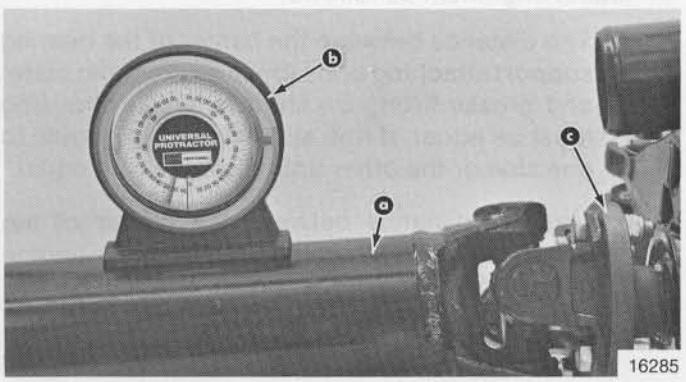
8. After engine has been aligned correctly, fasten front and rear engine mounts to stringers.
9. Position protractor on starter housing cover plate, as shown. Now, raise or lower front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as that recorded in Step 2.



16499

a - Flywheel Housing
b - Starter Housing Cover Plate
c - Protractor

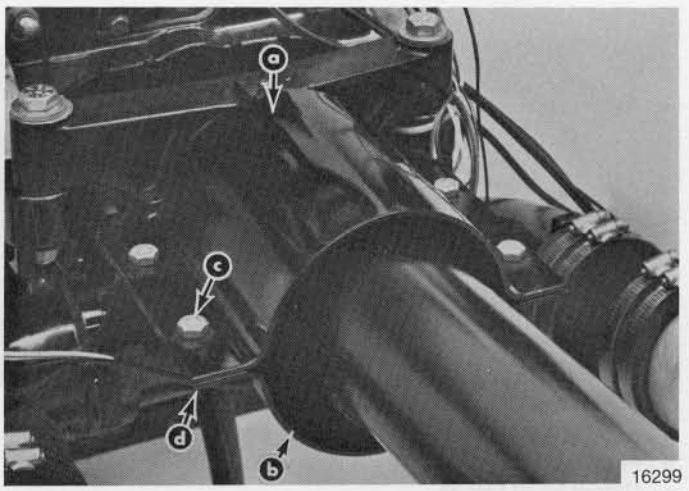
10. Position protractor on drive shaft as shown and recheck angle. Angle should be the same as that recorded in Step 5. If not, raise or lower all engine mount adjusting nuts an equal amount until correct angle is reached.



16285

a - Drive Shaft
b - Protractor
c - Output Shaft Flange

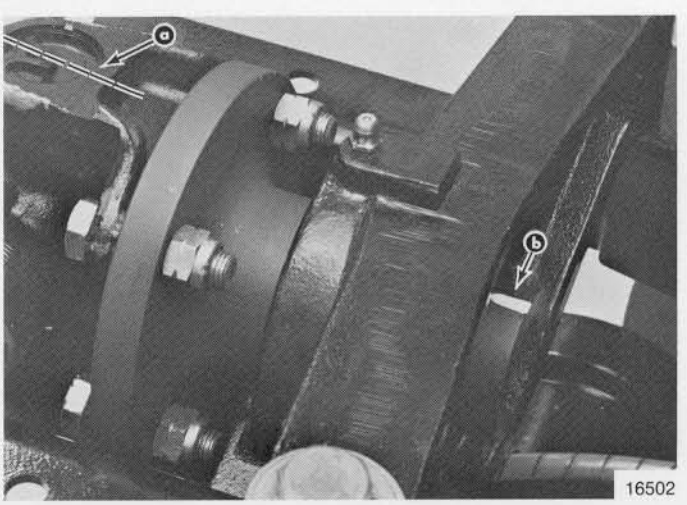
11. Tighten all engine mount locking nuts securely.
12. Remove alignment shaft from gimbal housing.
13. Install drive shaft shields.



16299

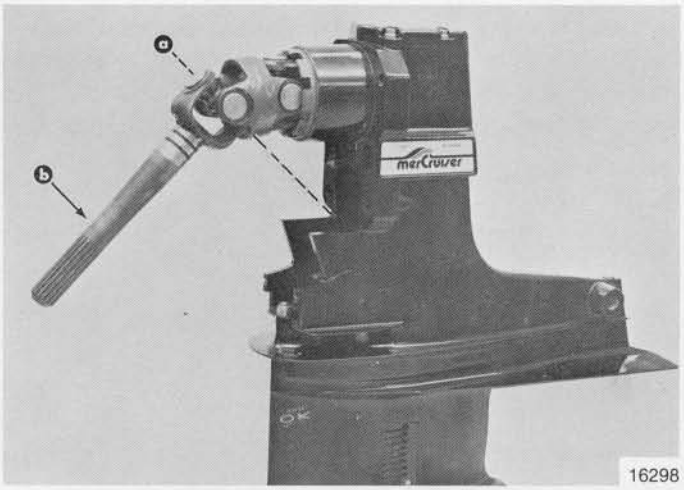
a - Top Shield
b - Bottom Shield
c - Screw (4 Used)
d - Nut (4 Used) (Torque to Specifications)

14. Install stern drive unit. Stern drive unit installation procedure is the same as that for the standard models, with the following exceptions:
    a. No alignment is necessary, other than to align gimbal bearing with bearing support input shaft. Step 2 and 3.
    b. Stern drive universal joints must be aligned with drive shaft universal joints, as shown. Place a reference mark (white paint) on shafts to correspond with universal joint centerlines. After installing stern drive, check to ensure that these marks are in alignment.



16502

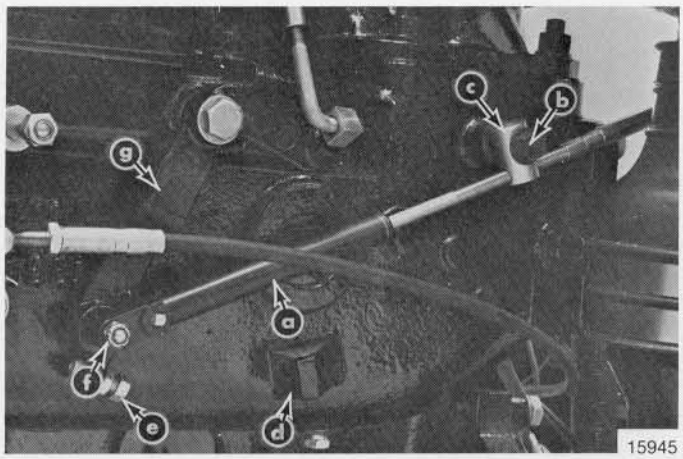
a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical
b - Place a Reference Mark Here to Correspond with "a"



a - Imaginary Centerline Running Thru This Universal Joint Bearing Must Be Vertical (Once Drive Unit is Installed)
b - Place a Reference Mark Here To Correspond with "a"

Attaching/Adjusting Throttle Cable

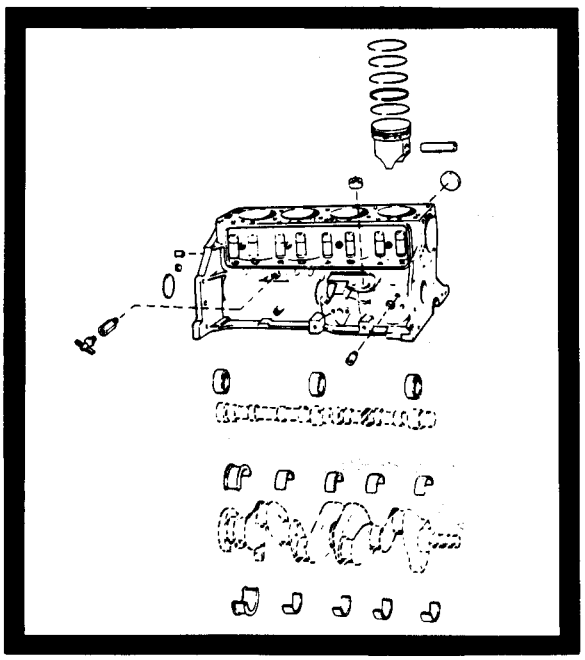
1. Place remote control in neutral gear, idle position.
2. Fasten cable end guide as shown.
3. Grasp throttle cable brass barrel and push cable lightly toward throttle lever. Adjust barrel to align with threaded hole in manifold. Fasten barrel as shown.
4. Check that throttle valves are fully open when remote control is in full throttle position. With throttle valves fully open, check wide open throttle stop screw. Turn screw until it just touches stop, then turn 1/4 turn more. Tighten set nut securely to prevent stop screw from turning.



a - Cable End Guide
b - Anchor Screw (Tighten Securely)
c - Brass Barrel (Cable Must Be Positioned As Shown)
d - W.O.T. Throttle Stop
e - W.O.T. Throttle Stop Screw
f - Washer and Nut (DO NOT Over-Tighten)
g - Throttle Lever

5. Return remote control to neutral gear, idle position. Check that idle stop screw is against stop.

ENGINE



G.M. IN-LINE

3

A

merCruiser
STERN DRIVES & INBOARDS

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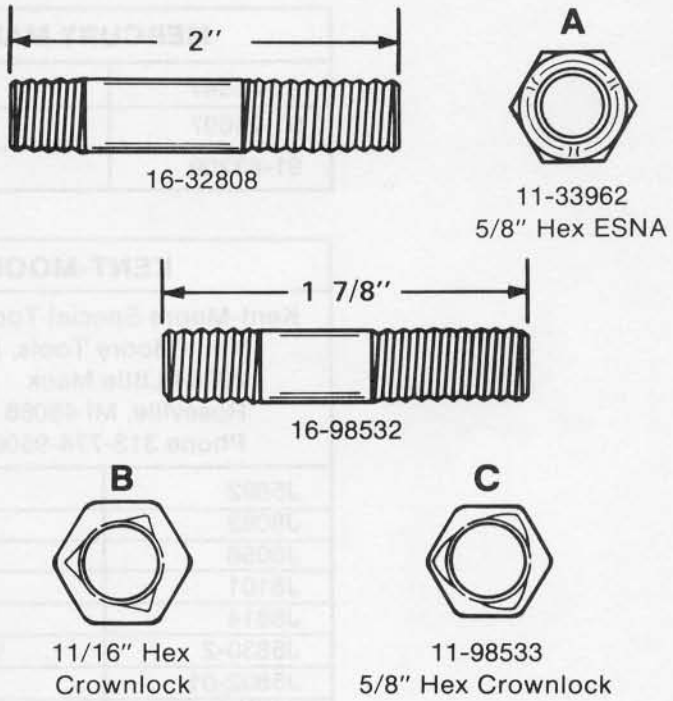
Torque Specifications

Fastener Location	Lbs. Ft. (N.m)
Camshaft Thrust Plate	6 (8)
Connecting Rod Cap (11/32-24)	33 (45)
Connecting Rod Cap (3/8-24)	40 (54)
Crankshaft Pulley (5/16-24)	18 (24)
Crankshaft Pulley (3/8-24)	23 (31)
Cylinder Head	Δ 93 (126)
Distributor Clamp	20 (27)
Engine Coupler/Flywheel	See Figure 1
Flywheel Housing to Block	21 (28)
Front Mount to Block	21 (28)
Main Bearing Cap	65 (88)
Manifold to Head	□ 23 (31)
Oil Pan - Side (1/4-20)	7 (9)
Oil Pan - End (5/16-18)	10 (14)
Oil Pan Drain Plug	23 (31)
Oil Pump Cover	6 (8)
Oil Pump to Block	10 (14)
Oil Pump Pickup	5 (7)
Rocker Arm Cover	4 (5)
Spark Plugs	15 (20)
Starter Motor	37 (50)
Timing Gear Cover	6 (8)
Water Pump to Block	15 (20)

Δ Retorque after first 20 hours of operation.

□ Retorque after first start up.

IMPORTANT: DO NOT intermix stud/nut combinations.

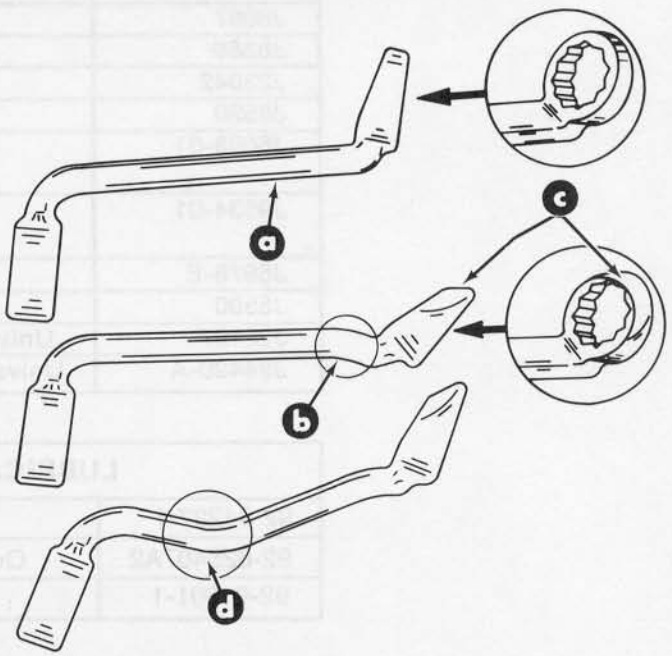


a - 45 lbs. ft. (61 N.m)
b - 35 lbs. ft. (42 N.m)
c - 40 lbs. ft. (54 N.m)

269-H

Engine Coupler/Flywheel Torque

Engine Coupler Wrench, 91-35547, may not work on the later couplers. Modify wrench as shown, so it will work on both earlier and later style couplings.



a - Original 91-35547 Wrench
b - Heat and Bend as Shown
c - Grind Area Shown Slightly
d - Heat and Bend as Shown (This is What Wrench Should Look Like When it's Done)

230-H

Modifying Engine Coupler Wrench

Tools/Lubricants/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-35547	Engine Coupler Wrench
91-24697	Piston Ring Expander
91-63209	Torch Lamp

KENT-MOORE SPECIAL TOOLS	
Kent-Moore Special Tools can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone 313-774-9500	
J5892	Valve Spring Compressing
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J8814	Valve Guide Reamer (Standard)
J5830-2	Valve Guide Reamer (.015" O.S.)
J5802-01	Rocker Arm Stud Remover
J6880	Rocker Arm Stud Installer
J5715	Stud Bore Reamer (.003" O.S.)
J6036	Stud Bore Reamer (.013" O.S.)
J8089	Carbon Remover Brush
J9510-1	Piston Support Tool
J24086-100	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Guide Tool (3/8"-24)
J8087	Cylinder Bore Checker
J8369	Oil Pump Suction Pipe Installer
J23042	Timing Cover Seal Aligner
J8520	Cam Lobe Lift Indicator
J6098-01	Camshaft Bearing Installer/ Remover Tool
J9534-01	Distributor Shaft Lower Bearing Installer/Remover
J6978-E	Pulley Hub Puller
J5590	Pulley Hub Installer
J22197	Universal Vibration Dampner Installer
J24420-A	Universal Vibration Dampner Remover

LUBRICANTS/SEALANTS	
92-34227-1	Quicksilver Perfect Seal
92-825407A2	Quicksilver 2-4-C Marine Lubricant
92-91601-1	Quicksilver RTV Sealer

Engine Specifications

UNIT OF MEASUREMENT in. (mm)

MODEL	120 - 2.5 Litre	140 - 3.0 Litre
DISPLACEMENT	153 CID	181 CID

CYLINDER BORE:

Diameter			3.8745-3.8775 (98.412-98.489)	3.9995-4.0075 (101.5873-101.7905)
Out of Round		Production	.0005 (.0127) Max.	
		Service	.002 (.0508) Max.	
Taper	Production	Thrust Side	.0005 (.0127) Max.	
		Relief Side	.0005 (.0127) Max.	
	Service		.0005 (.0127) Max.	

PISTON: CLEARANCE

Production	.0005-.0015 (.0127-.0381)
Service	.0025 (.06) Max.

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	.0012-.0027 (.0305-.0686)
		2nd	.0012-.0032 (.0305-.0813)
	Service	Top	.001-.003 (.03-.09)
		2nd	.001-.004 (.03-.1)
Gap	Production	Top	.010-.020 (.254-.508)
		2nd	.010-.020 (.254-.508)
	Service	Top	.010-.030 (.25-.75)
		2nd	.010-.030 (.25-.75)

PISTON RING: OIL

Groove Clearance	Production	.000-.005 (.127)
	Service	.000-.006 (.15)
Gap	Production	.015-.055 (.381-1.397)
	Service	.015-.065 (.4-1.65)

PISTON PIN:

Diameter		.9270-.9273 (23.546-23.553)
Clearance	Production	.00015-.00025 (.038-.006)
	Service	.001 (.025) Max.
Fit in Rod		.0008-.0016 (.020-.041) Interference

CRANKSHAFT:

Main Journal	Diameter		All 2.2983-2.2993 (5.838-5.840)
	Taper	Production	.0002 (.005) Max.
		Service	.001 (.025) Max.
	Out of Round	Production	.0002 (.005) Max.
		Service	.001 (.025) Max.
Main Brg. Clearance	Production		.0003-.0029 (.008-.074)
	Service		.004 (.1) Max.

(Continued on Next Page)

Engine Specifications (Continued)

MODEL			120 - 2.5 Litre	140 - 3.0 Litre
Crankshaft End Play			.002-.006 (.05-.15) Max.	
Crankpin	Diameter		1.999-2.000 (50.775-50.800)	2.099-2.100 (53.315-53.340)
	Taper	Production	.0003 (.0076) Max.	
		Service	.001 (.025) Max.	
	Out of Round	Production	.0002 (.051) Max.	
		Service	.001 (.025) Max.	
Rod Brg. Clearance	Production		.0007-.0027 (.018-.069)	.0007-.0028 (.018-.071)
	Service		.004 (.1) Max.	
Rod Side Clearance			.009-.013 (.25-.3)	

CAMSHAFT:

Lobe Lift (Max.)	Intake	.2325 (5.906)	.2525 (6.414)
	Exhaust	.2325 (5.906)	.2525 (6.414)
Journal Diameter		1.8682-1.8692 (47.452-47.478)	
Camshaft Runout		.0015 (.038) Max.	

CYLINDER HEAD:

Gasket Surface Flatness	.003" (.07) in Any 6" (152) or .007" (.15) Overall Max.

VALVE SYSTEM:

Lifter			Hydraulic	
Rocker Arm Ratio			1.75 to 1	
Collapsed Tappet Gap			1 Turn Down from "O" Lash	
Face Angle		Intake	45°	
		Exhaust	45°	
Seat Angle (Int. & Exh.)			46°	
Seat Runout (Int. & Exh.)			.002 (.051) Max.	
Seat Width		Intake	1/32-1/16 (.8-1.6)	
		Exhaust	1/16-3/32 (1.6-2.4)	
Stem Clearance	Production	Int.	.0010-.0027 (.025-.069)	
		Exh.	.0015-.0032 (.038-.081)	
	Service	Int.	.0037 (.094) Max.	
		Exh.	.0052 (.132) Max.	
Springs	Free Length		2-5/16 [2.08 (53)]	
	Pressure Lbs. Ft.	Closed	78-86 (106-116 N.m) at 1-21/32 [1.66 (42.2)]	83 (113 N.m) at 1-21/32 [1.66 (42.2)]
		Open	170-180 (230-244 N.m) at 1-17/64 [1.26 (32)]	175 (237 N.m) at 1-17/64 [1.26 (32)]
	Installed Height ± 1/32" (.8)	Intake	1-21/32 [1.6562 (42.07)]	
		Exhaust	1-21/32 [1.6562 (42.07)]	
Damper	Free Length		1-15/16 [1.94 (49.2)]	
	Approx. No. of Coils		4	

(Continued on Next Page)

General

Some Repairs, Listed in This Section, Must Be Completed with Engine Removed from Boat. Engine Removal Depends Upon Type of Repair and Boat Design. Place Engine on Engine Stand for Major Repairs.

In-line engines with 153 and 181 cu. in. displacements are covered in this section.

Full pressure lubrication thru a full flow oil filter is furnished by a gear-type oil pump. Distributor, driven by a helical gear on camshaft, drives oil pump. Main oil gallery feeds oil thru drilled passages to camshaft and crankshaft to lubricate bearings. Main oil gallery also feeds valve lifters which, thru push rods, feed individually-mounted rocker arms.

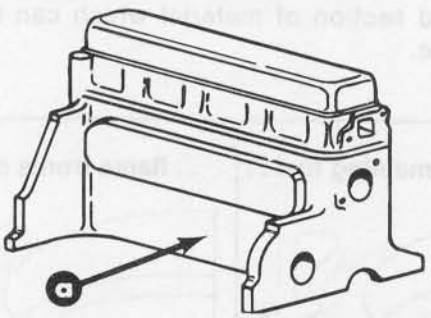
Cubic inch displacement (CID) of each MerCruiser model is listed below.

Model	No. of Cylinders	Cu. In. Displacement
MCM 120 - 2.5 Litre	4	153 (2.5 ltr.)
MCM 140 - 3.0 Litre	4	181 (3 ltr.)

ENGINE IDENTIFICATION

The MerCruiser Model can be determined by looking at the LAST TWO LETTERS of the engine code stamped into the cylinder block. This code number is stamped on all MerCruiser Power Packages and replacement partial engines but not replacement cylinder block assemblies.

If the engine serial number, and/or model decals are missing, the engine code letters may help in determining the engine model. Following is a list of G.M. engines and their respective code letters.



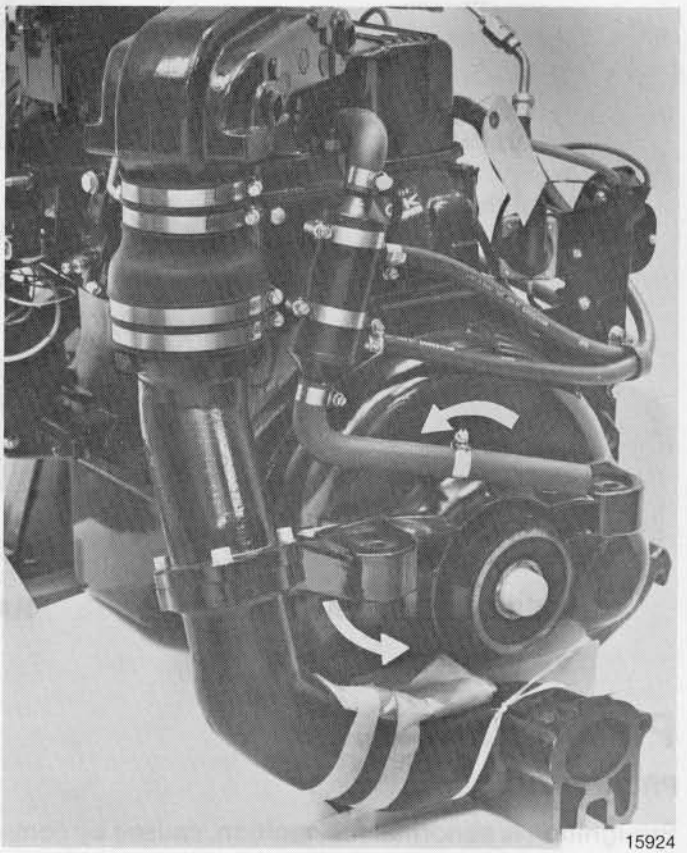
a - 4 Cylinder-In-Line (Near Distributor)

G.M. Engine Code Location

MCM Stern Drive Engines (All Are LH Rotation)

120 -2.5 Litre-NB
140-RA
3.0 Litre-RS/RA

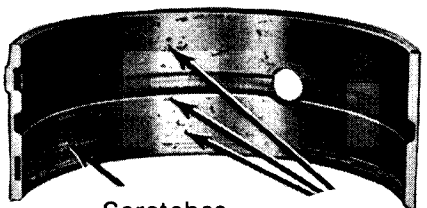
ENGINE ROTATION



15924

All Engines Are Left Hand Rotation When Viewed from Flywheel End

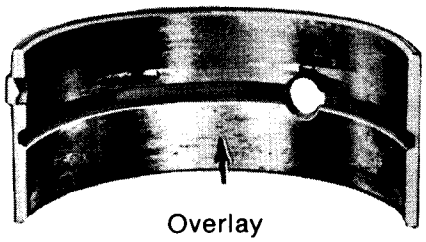
Bearing Failures



Scratches

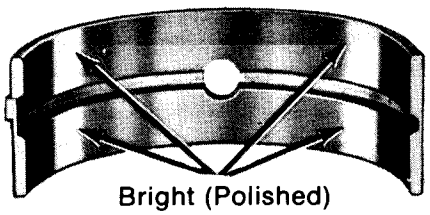
Dirt Imbedded into Bearing Material

SCRATCHED BY DIRT



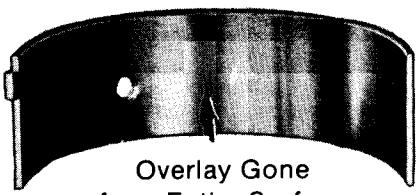
Overlay Wiped Out

LACK OF OIL



Bright (Polished) Sections

IMPROPER SEATING

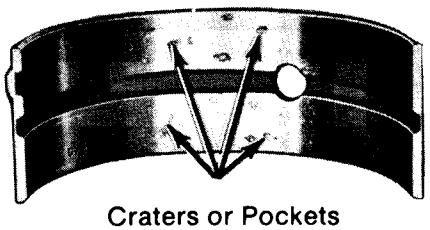


Overlay Gone from Entire Surface

TAPERED JOURNAL

Radius Ride

RADIUS RIDE



Craters or Pockets

FATIGUE FAILURE

Piston Failures

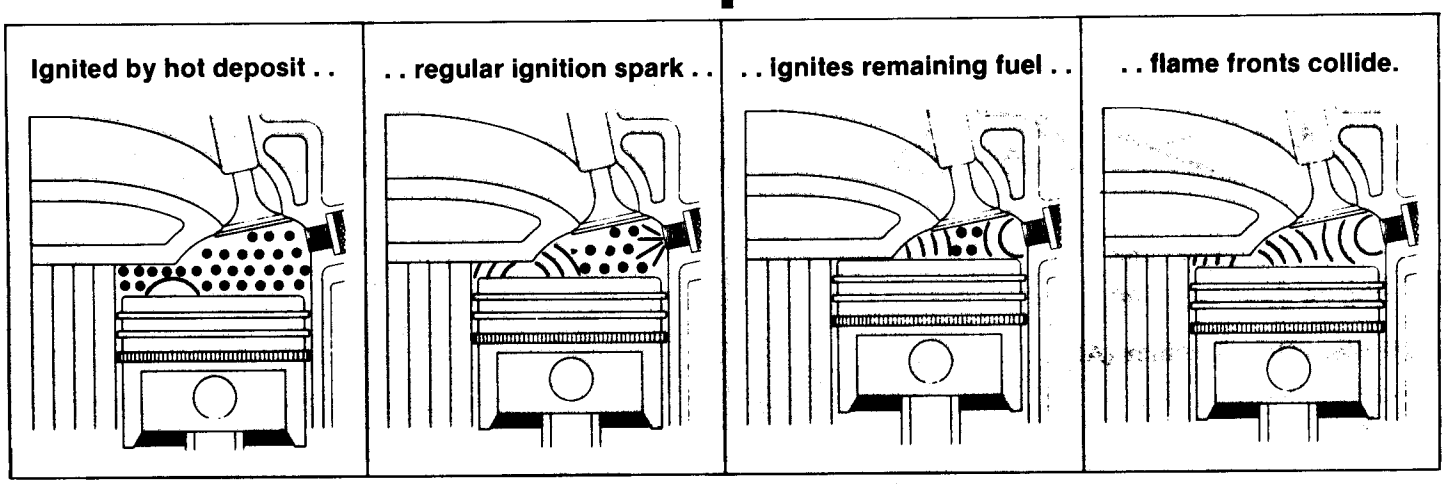
PRE-IGNITION

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.

Pre-Ignition Damage

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.



DETONATION

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

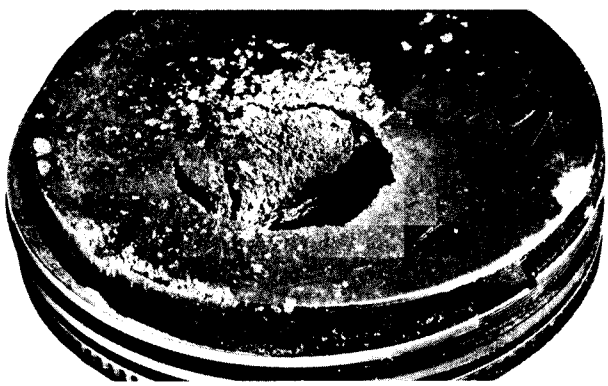
Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES of DETONATION

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

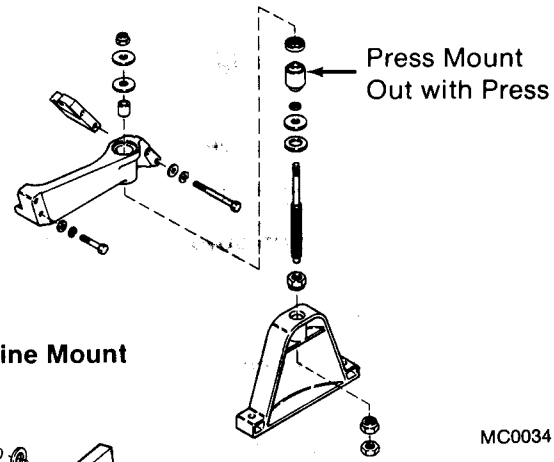
1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.



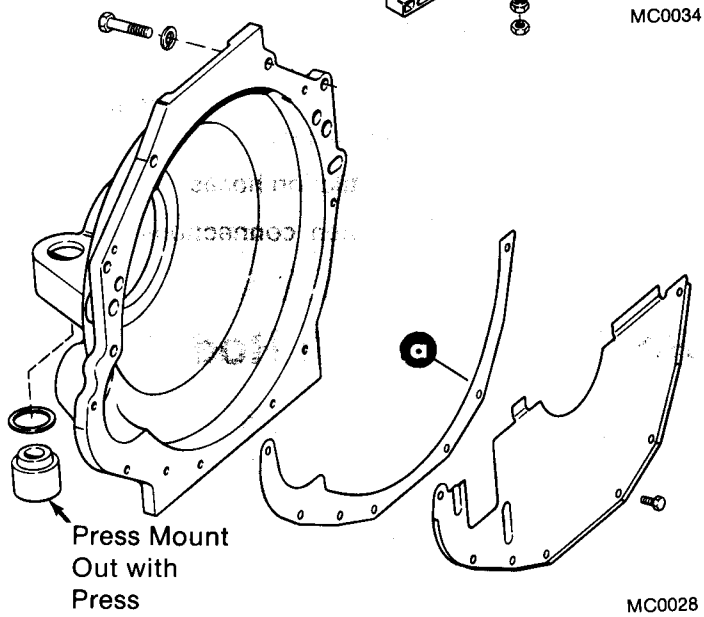
Detonation Damage

Front/Rear Engine Mount



Front Engine Mount

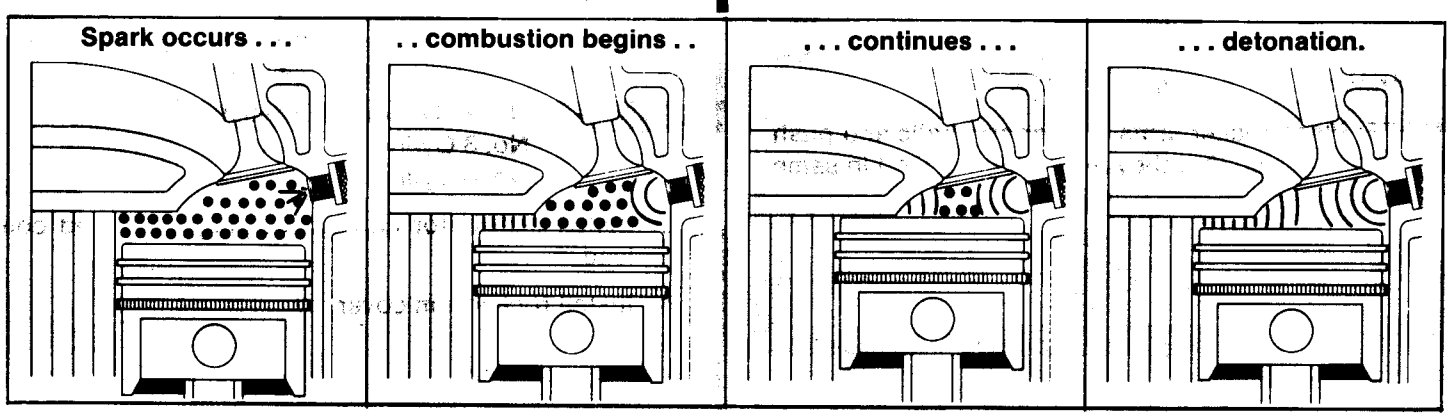
MC0034



MC0028

a - Gasket used on 120R/140R Engine Only

Rear Engine Mount/Flywheel Housing



Rocker Arm Cover

REMOVAL

1. Disconnect crankcase ventilation hose at rocker arm cover.
2. Disconnect and remove fuel line.
3. Remove attaching bolts.
4. Remove rocker arm cover and gasket.

INSTALLATION

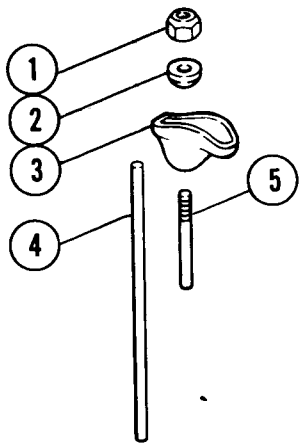
1. Clean gasket surfaces on cylinder head and rocker arm cover.
2. Using a new gasket, install rocker arm cover and torque to specifications.

NOTE: Wiring harness and inlet hose clips must be installed under their proper screws.

3. Connect crankcase ventilation hoses.
4. Replace fuel line. Tighten connections securely and check for leaks.

Rocker Arm/Push Rod

1 - Nut
2 - Ball Unit
3 - Rocker Arm
4 - Push Rod
5 - Rocker Arm Stud



Valve Mechanism

REMOVAL

1. Remove rocker arm cover as outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arm and push rods.

NOTE: Place rocker arms, rocker arm balls and push rods in a rack so that they may be reinstalled in same location.

INSTALLATION

NOTE: Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods. Be sure that push rods seat in lifter socket.
2. Install rocker arms, ball units and rocker arm nuts.
3. Adjust valves.
4. Install rocker arm cover.
5. Adjust carburetor idle speed and mixture.

Valve Adjustment

Engine Not Running

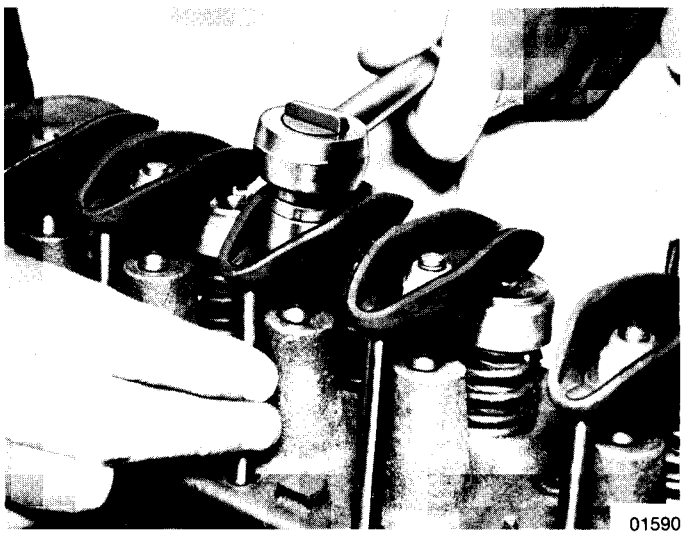
1. Remove valve cover.
2. Adjust valves when lifter is on low lobe on camshaft, as follows:
   a. Mark distributor housing with chalk at No. 1 and No. 4 cylinder spark plug wire location for 4-cylinder engine. Disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.
   b. Crank engine until distributor rotor points to No. 1 cylinder position and breaker points are open. Following valves can be adjusted with engine in No. 1 firing position.

      No. 1 Cylinder - Exhaust and Intake
      No. 2 Cylinder - Intake
      No. 3 Cylinder - Exhaust
      No. 4 Cylinder - Intake

   c. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod end play (up and down) while turning adjusting nut. When play is removed, turn adjusting nut in 1 additional turn.
   d. Crank engine until distributor rotor points to No. 4 position for 4-cylinder engine and breaker points are open. Following valves can be adjusted with engine in this position:

      No. 2 Cylinder - Exhaust
      No. 3 Cylinder - Intake
      No. 4 Cylinder - Exhaust

3. Install distributor cap, spark plug wires and coil lead.
4. Install rocker arm cover.



Valve Adjustment

Engine Running

Following procedure should be completed only if readjustment is required.

1. Run engine until it reaches normal operating temperature, then remove valve cover.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter.
3. Turn rocker arm nut down slowly until clatter just stops. This is zero lash position.
4. Turn nut down 1/4 additional turn and pause 10 seconds until engine runs smoothly. Repeat additional 1/4 turns, pausing 10 seconds each time, until nut has been turned down 1 turn from zero lash position.

NOTE: This 1 turn pre-load adjustment must be done slowly to allow lifter to adjust itself, thus preventing possible interference between inlet valve head and top of piston which might result in internal damage and/or bend push rods.

5. Repeat Steps 2-3-4 to adjust other valves.
6. Install valve cover, using new gasket.
7. Adjust carburetor.

Hydraulic Valve Lifters

Hydraulic valve lifters seldom require attention. Lifters are simple in design, readjustments are not necessary and lifter servicing requires only that care and cleanliness be exercised in handling of parts.

Locating Noisy Lifters

Use a piece of garden hose approximately 4 ft. (1.2m) in length to locate a noisy valve lifter. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. Sound, thus, is localized, making it easy to determine which lifter is at fault. Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat. General types of valve lifter noise are:

1. Hard Rapping Noise - Usually caused by plunger becoming tight in bore of lifter body to such an extent that return spring can no longer push plunger back up to working position. Probable causes are -
   a. Excessive varnish or carbon deposit which causes abnormal stickiness.
   b. Galling or "pickup" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedging between plunger and lifter body.
2. Moderate Rapping Noise - Probable causes are -
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General Noise Throughout Valve Train - This, in most cases, will be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent Clicking - Probable causes are -
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in a solvent, reassembled and reinstalled in engine. If dirt, varnish, carbon, etc, are shown to exist in one unit, it likely exists in all units. Thus, it would be only a matter of time before all lifters cause trouble.

Removal

1. Remove rocker arm and push rod.
2. Mark distributor housing with chalk at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.
3. Crank engine until distributor rotor points to No. 1 position, then disconnect distributor primary lead at coil and remove distributor.

4. Remove push rod covers (discard gaskets).
5. Remove valve lifters.

NOTE: Place valve lifters in a rack so they may be reinstalled in same location.

Servicing

Two types of hydraulic lifters are used. Both types operate on same principle and are serviced basically in same manner. Complete lifter assemblies are interchangeable, but parts from one lifter are not interchangeable with another. Both lifters are easily identified by outside configuration of lifter body. Identify them as lifter "A" and lifter "B".

Disassembly

1. Hold plunger down with push rod and remove push rod seat retainer with blade of small screwdriver.
2. Remove push rod seat and metering valve lifter "A" (or push rod seat and inertia valve assembly lifter "B").
3. Remove plunger, ball check valve assembly and plunger spring.
4. Remove ball check valve and spring by prying ball retainer loose from plunger with blade of small screwdriver.

Cleaning and Inspection

Thoroughly clean all parts in cleaning solvent and inspect parts carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If outside of lifter body is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod.

NOTE: Do not remove inertia valve and retainer (lifter "B") from push rod seat. To check valve, shake push rod seat and inertia valve assembly. Valve should move.

Reassembly

1. Place check ball on small hole in bottom of plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on ball. Carefully press retainer into position in plunger with blade of a small screwdriver.

⚠CAUTION

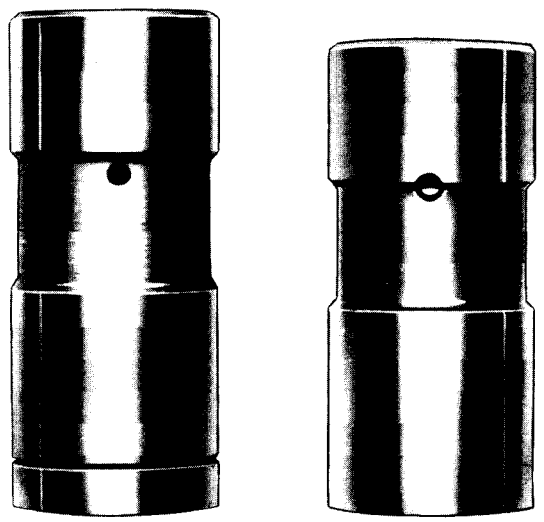
Do not attempt to force or pump the plunger.

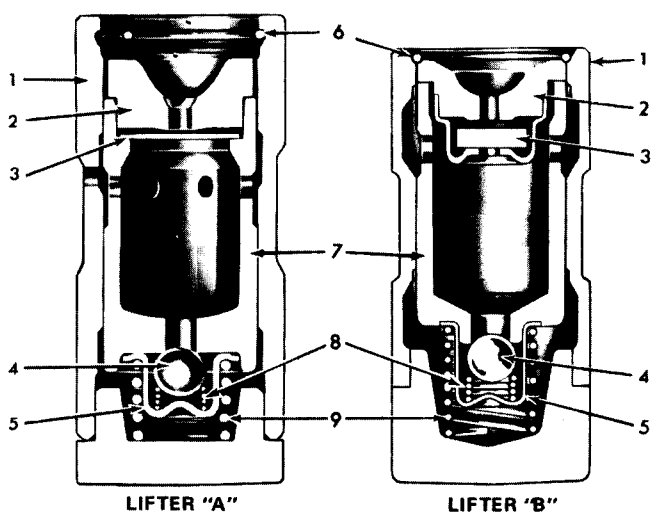
3. Place plunger spring over ball retainer and slide lifter body over spring and plunger, being careful that oil feed holes in lifter body and plunger line up.
4. Fill assembly with oil, then insert end of a 1/8" (3mm) drift pin into plunger and press down strongly. At this point, oil holes in lifter body and plunger assembly will be aligned.
5. Insert a 1/16" (1.5mm) drift pin thru both oil holes to hold plunger down against lifter spring tension.

NOTE: On lifter "B" drift pin must not extend inside plunger.

6. Remove 1/8" drift pin and refill assembly with oil.
7. Install metering valve and push rod seat lifter "A" (or push rod seat and inertia valve assembly lifter "B").
8. Install push rod seat retainer, press down on push rod seat and remove 1/16" drift pin from oil holes. Lifter now is completely assembled, filled with oil and ready for installation.

NOTE: Before installing a new lifter, coat bottom of lifter with engine oil.

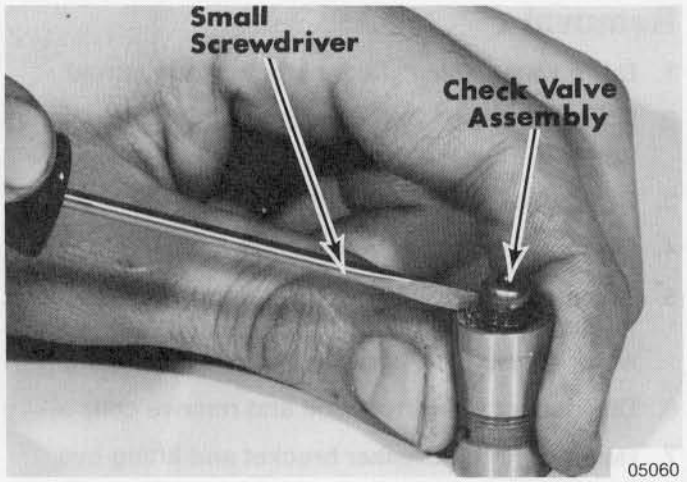




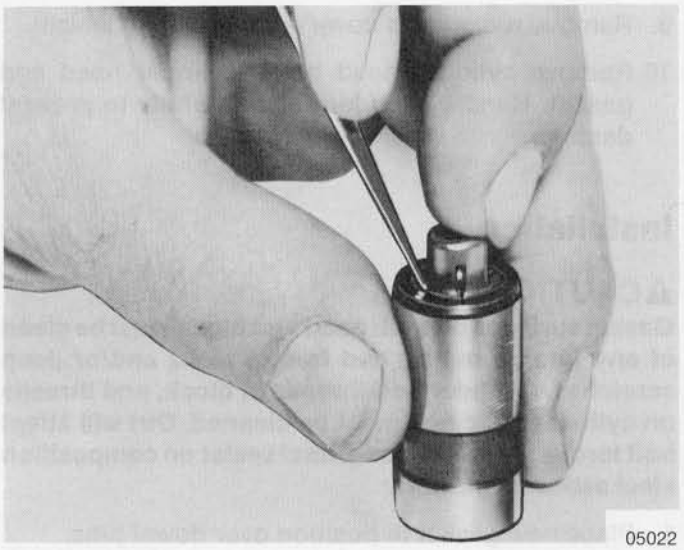
05030

1 - Lifter Body
2 - Push Rod Seat
3 - Metering Valve (Lifter "A")
Inertia Valve (Lifter "B")
4 - Check Ball
5 - Check Ball Retainer
6 - Push Rod Seat Retainer
7 - Plunger
8 - Check Ball Spring
9 - Plunger Spring

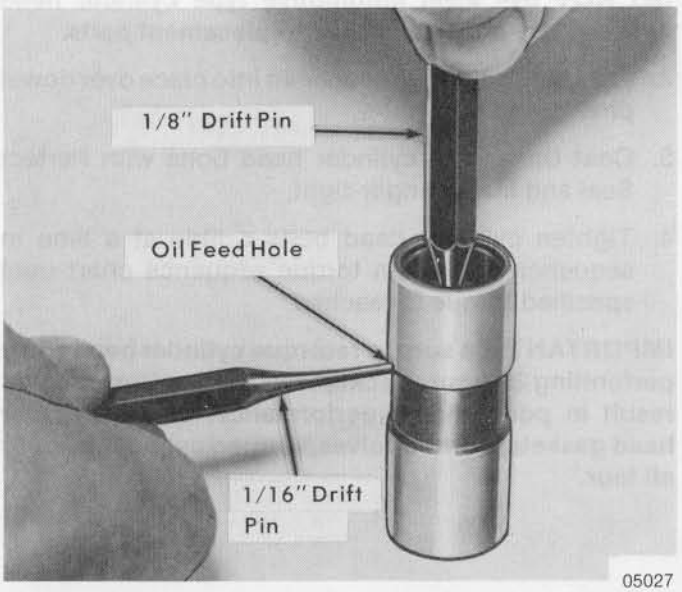
Hydraulic Valve Lifters



Removing Ball Check Valve



Installing Ball Check Valve



Assembling Hydraulic Lifters

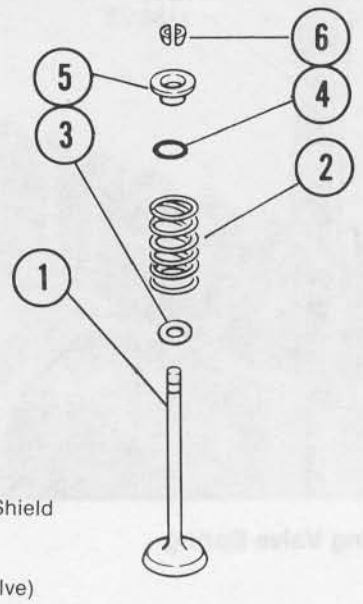
Installation

1. Install valve lifters.

NOTE: Whenever valve lifters are being installed, coat bottom of valve lifters with engine oil.

2. Install push rod covers, using new gaskets, and torque to specifications.
3. Install distributor, positioning rotor to No. 1 cylinder position, then connect primary lead at coil.
4. Install distributor cap and high tension wires.
5. Install and adjust valves.
6. Adjust ignition timing, carburetor idle speed and mixture.

Valve Stem Oil Seal and/or Valve Spring



1 - Valve
2 - Valve Spring
3 - Valve Spring Shield
4 - Seal
5 - Cap
6 - Keys (2 per valve)

Valve Spring and Related Parts

Replacement

1. Remove rocker arm cover.
2. Remove spark plug, rocker arm and push rod on cylinder to be serviced.
3. Place piston for that cylinder at TDC to prevent valves from dropping into combustion chamber.

NOTE: A tool to apply air to cylinder is available thru local jobbers. Engines use tapered spark plugs.

4. Compress valve spring with Tool J-5892 and remove valve keys, valve spring cap, spring shield and valve spring.
5. Remove valve stem oil seal.

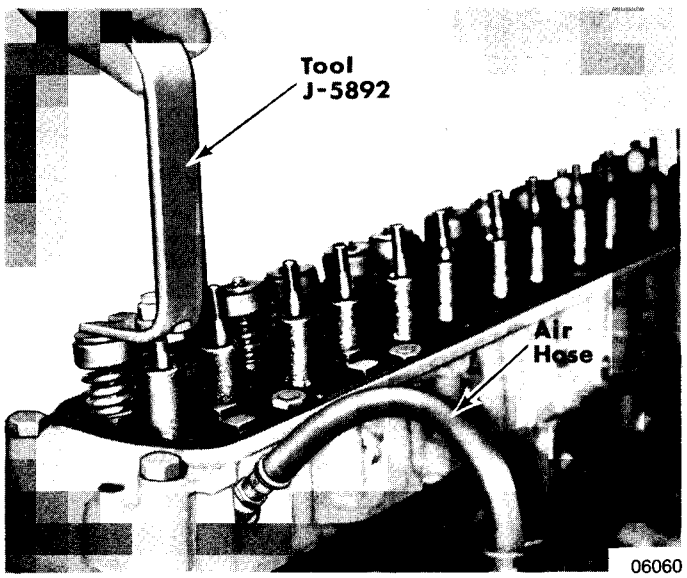
6. To install, set valve spring, (close, coiled end of spring is installed against cylinder head) valve shield and valve cap in place. Compress spring with Tool J-5892 and install oil seal in lower groove of stem, making sure that seal is flat and not twisted.

NOTE: A light coat of oil on seal will help prevent twisting when compressor tool is released.

7. Install valve keys and release compressor tool. Be sure that keys seat properly in upper groove of valve stem.

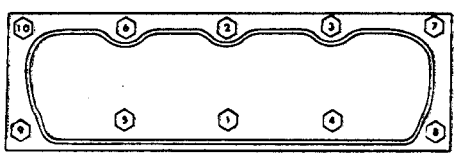
NOTE: Grease may be used to hold keys in place while releasing compressor tool.

8. Install spark plug and torque to specifications.
9. Repeat Steps 2 thru 8 for other cylinders.
10. Install and adjust valve mechanism.



Compressing Valve Spring

Cylinder Head



Cylinder Head Torque Sequence

Removal

1. Drain water from cylinder block and manifold.
2. Disconnect fuel line support clamps and remove fuel line.
3. Remove exhaust manifold.
4. Disconnect cooling hoses.
5. Disconnect wire from temperature sending unit (located in water distribution housing) and remove water distribution housing from cylinder head.
6. Disconnect wires from coil and remove coil.
7. Remove circuit breaker bracket and lifting eye.
8. Disconnect spark plug leads from spark plugs and remove all spark plugs from cylinder head.
9. Remove rocker arm cover and valve mechanism.
10. Remove cylinder head bolts, cylinder head and gasket. Handle cylinder head carefully to prevent damage.

Installation

⚠CAUTION

Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks and/or deep scratches. Cylinder bolt threads in block, and threads on cylinder head bolt must be cleaned. Dirt will affect bolt torque. DO NOT use gasket sealer on composition steel asbestos gaskets.

1. Place new gasket in position over dowel pins.

⚠CAUTION

DO NOT use steel automotive type cylinder head gaskets. Use only Quicksilver replacement parts.

2. Carefully guide cylinder head into place over dowel pins and gasket.
3. Coat threads of cylinder head bolts with Perfect Seal and install finger-tight.
4. Tighten cylinder head bolts a little at a time in sequence shown on torque sequence chart until specified torque is reached.

IMPORTANT: Be sure to retorque cylinder head while performing 20-hour checkup. Failure to retorque could result in poor engine performance, blown cylinder head gaskets, burned valves, warped cylinder head or all four.

5. Install valve mechanism and rocker arm cover.
6. Install spark plugs and spark plug leads to proper plugs.
7. Install lifting eye and circuit breaker bracket.
8. Install coil and coil leads.
9. Install water distribution housing to cylinder head and connect temperature sending unit lead.
10. Connect cooling hoses to water distribution housing.
11. Install exhaust manifold.
12. Install fuel line and fuel line support clamps.

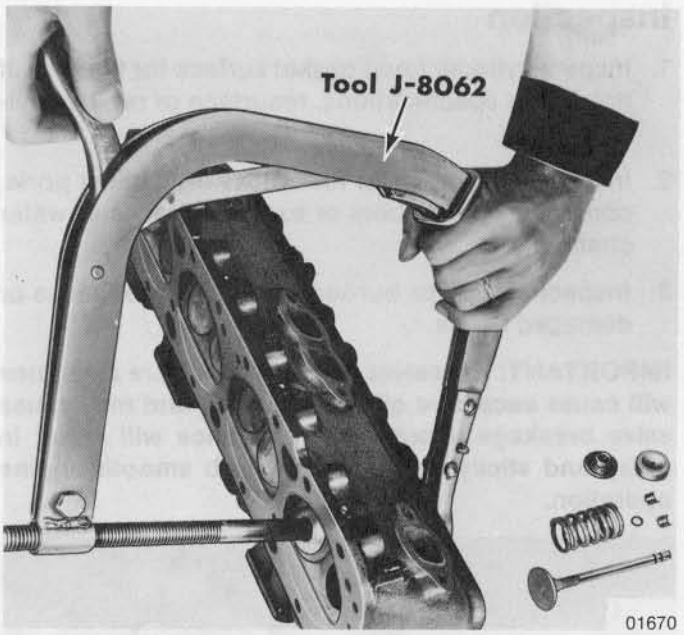
Cylinder Head and Valve Conditioning

Disassembly

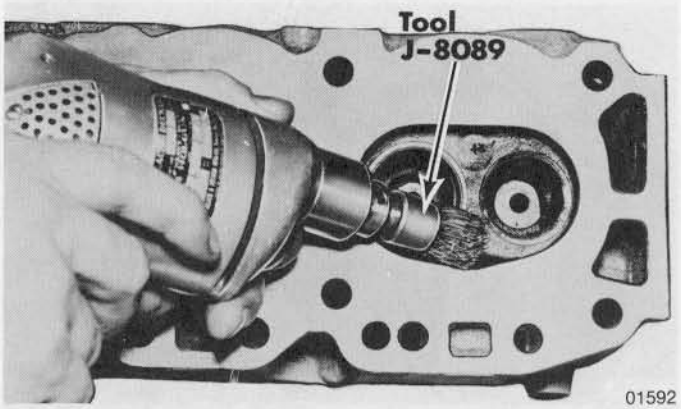
1. Remove cylinder head.
2. Compress the valve springs with Tool J-8062 and remove valve keys. Release compressor tool and remove spring caps, spring shields and valve springs. Remove oil seals from valves.
3. Remove valves from cylinder head and place them in a rack in their proper sequence for later assembly in their original positions.

Cleaning

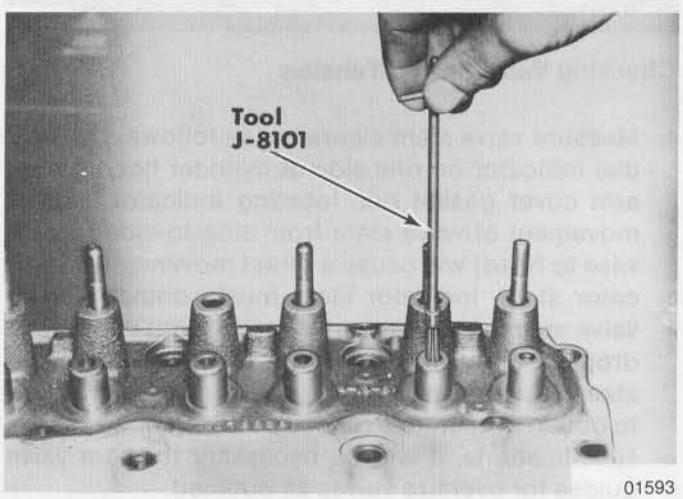
1. Clean all carbon from combustion chambers and valve ports with Tool J-8089.
2. Thoroughly clean valve guides with Tool J-8101.
3. Clean all sludge from push rods, rocker arms and push rod guides.
4. Clean valve stems and valve heads on a buffing wheel.
5. Clean cylinder head gasket mating surface.



Compressing Valve Spring



Cleaning Combustion Chambers

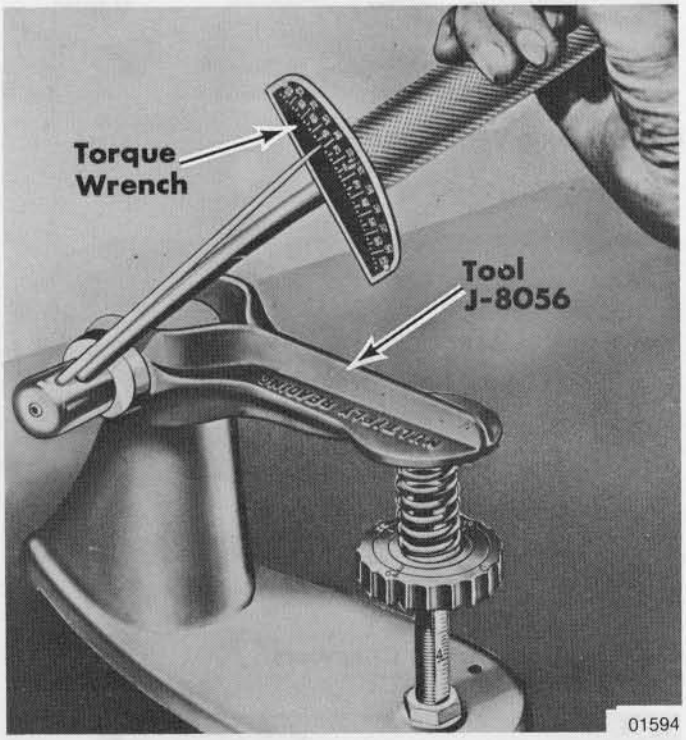


Cleaning Valve Guides

Inspection

1. Inspect cylinder head gasket surface for flatness. If not within specifications, resurface or replace cylinder head.
2. Inspect cylinder head for cracks in exhaust ports, combustion chambers or external cracks to water chamber.
3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky valves and disturb smooth engine operation.



Checking Valve Spring Tension

4. Measure valve stem clearance as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (1.5mm) off valve seat, move stem of valve from side-to-side, using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves as outlined.
5. Check valve spring tension with Tool J-8056 spring tester. Replace if not within 10 lbs. of specified load (without dampers).
6. Inspect rocker arm studs for wear or damage.

Rocker Arm Studs

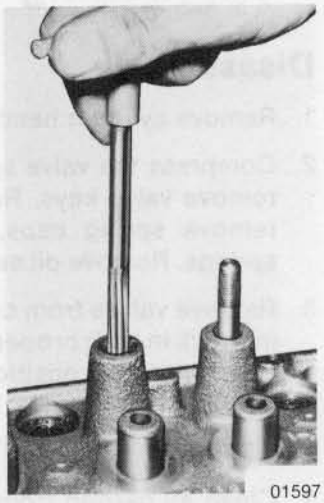
Rocker arm studs with damaged threads or with loose fit in cylinder heads should be replaced with new, oversize studs. Studs may be installed after reaming holes as follows:

1. Drain water from cylinder block.
2. Remove old stud by placing Tool J-5802-01 over stud, installing nut and flat washer and removing stud by turning nut.
3. Ream hole for oversize stud with Tool J-5715 for .003" oversize or Tool J-6036 for .013" oversize.

IMPORTANT: Do not attempt to install an oversize stud without reaming stud hole.

4. Coat press-fit area of stud with Perfect Seal. Install new stud, using Tool J-6880 as a guide. Gauge should bottom on head.

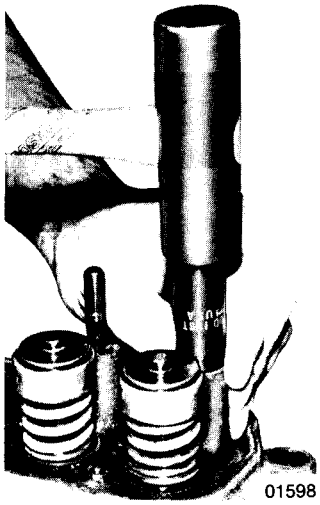
Removing Rocker Arm Stud



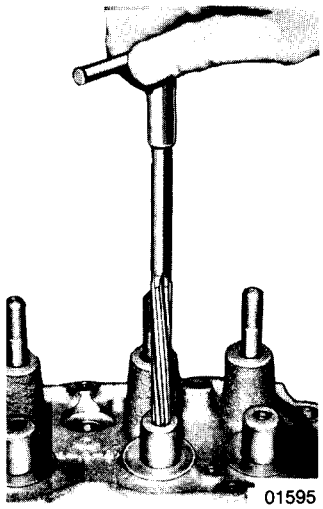
Reaming Rocker Arm Stud Bore

Valve Guide Bores

Valves with oversize stems are available (see specifications). To ream valve guide bores for .015" oversize valves, use Tool J-5830-2 and for standard, use Tool J-8814.



Installing Rocker Arm Stud



Reaming Valve Guide

Valve Seats

1. Valves must seat perfect for the engine to deliver the power and performance built into it.
2. Good contact between each valve and its seat in head is a must to ensure that heat in valve head will be properly carried away (cooled).
3. Recommendations of equipment manufacturer for reseating valve seats should be carefully followed to attain proper results. Regardless of what type of equipment is used, however, it is essential that valve guide bores be free from carbon or dirt.
4. After grinding valve seat, check seat for out-of-round. (Max. is .002" [.05mm] out-of-round with total indicator reading.)

Measuring Valve Seat Concentricity

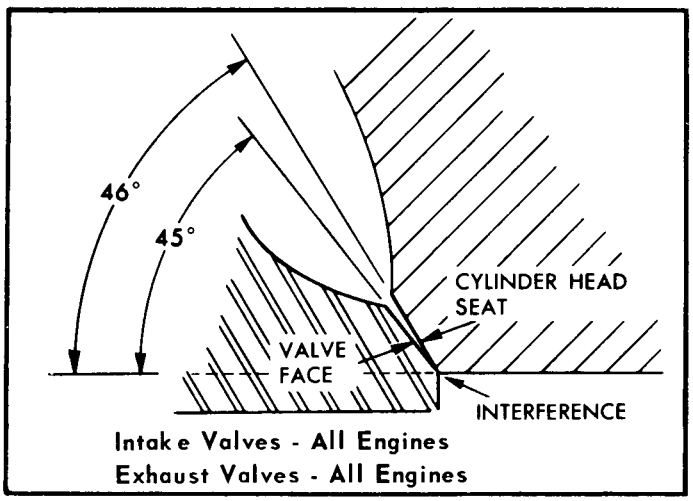
Valves

Pitted valves can be refaced to proper angle thus ensuring correct relation between head and stem on valve refacing mechanism. Valve stems, which show excessive wear or valves that are warped excessively, should be replaced. When a valve head (warped excessively) is refaced, a knife edge will be ground on part or all of valve head due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition from heat localizing on this knife edge. If edge of valve head is less than 1/32" (.8mm) thickness after grinding, replace valve.

Recommendations of equipment manufacturer for refacing valves should be carefully followed to obtain best results.

IMPORTANT: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

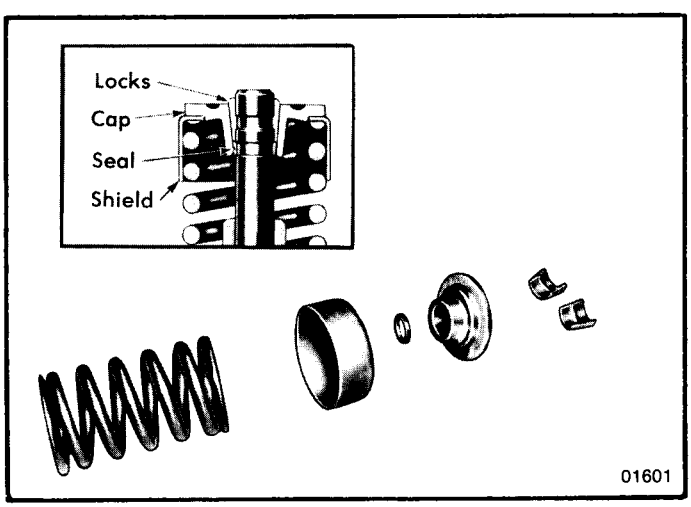
1. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about 1/4" (6mm) apart across valve face, place valve in cylinder head and give valve 1/2-turn in each direction while exerting firm pressure on head of valve.
2. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, it will be necessary to repeat refacing operation and again recheck for proper seating.
3. Grind and check remaining valves in same manner.



Relation of Valve and Seat Angles

Reassembly

1. Insert valve in proper port.
2. Using compressor tool, assemble valve spring and related parts as outlined in "Valve Stem Oil Seal and/or Valve Spring". (Steps 6 and 7)
3. Install remaining valves.
4. Check each valve stem oil seal by placing a vacuum cup or similar device over end of valve stem and against cap. Operate vacuum cup and make sure that no air leaks past seal.
5. Check installed height of valve springs with scale. Measure from top of spring seat to top of valve spring shield. If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.5mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.



Valve Spring Installation

Checking Valve Spring Installed Height

Oil Pan

Removal

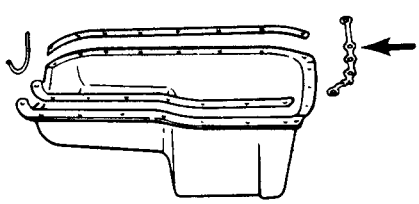
1. Disconnect battery.

NOTE: Removal of engine from boat may be required.

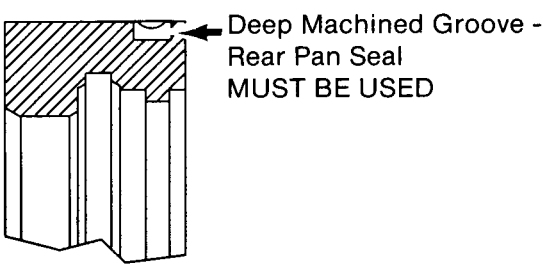
2. Drain engine oil.
3. Remove starter motor.
4. Remove oil pan screws, oil pan, and gasket(s).

Installation

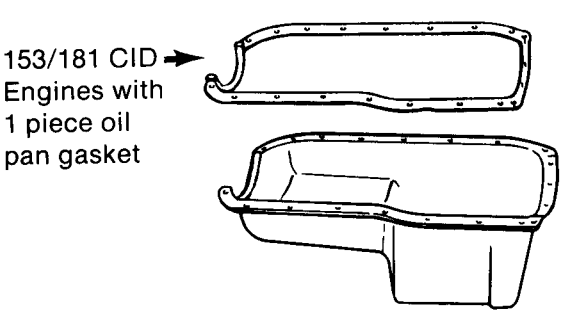
1. Thoroughly clean all gasket sealing surfaces.
2. Refer to Figures below for installation of gasket.
3. Install oil pan.
4. Install starter motor.
5. Fill crankcase with oil.
6. Connect battery.



Rear Main Bearing Cap



Oil Pan



Oil Pump

Oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft. A baffle is incorporated on pickup screen to eliminate pressure loss.

Removal

1. Remove oil pan.
2. Remove flange mounting bolts and pickup pipe bolt, then remove pump and screen as an assembly.

Disassembly

IMPORTANT: DO NOT remove pickup screen and pipe assembly unless replacement is necessary. Loss of press fit condition could result in air leak and loss of oil pressure.

1. Remove pump cover attaching screws, pump cover and pump cover gasket.

IMPORTANT: Mark gear teeth so they may be reassembled with same teeth indexing.

2. Remove idler gear and drive gear and shaft from pump body.
3. Remove pressure regulator valve retaining pin, pressure regulator, spring and valve.
4. If pickup screen and pipe assembly need replacing, mount pump in a soft-jawed vise and extract pipe from pump.

IMPORTANT: Do not disturb pickup screen on pipe which is serviced as an assembly.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
4. Check drive gear shaft for looseness in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen, pipe or relief grommet.
7. Check pressure regulator valve for fit.

NOTE: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replace entire oil pump assembly.

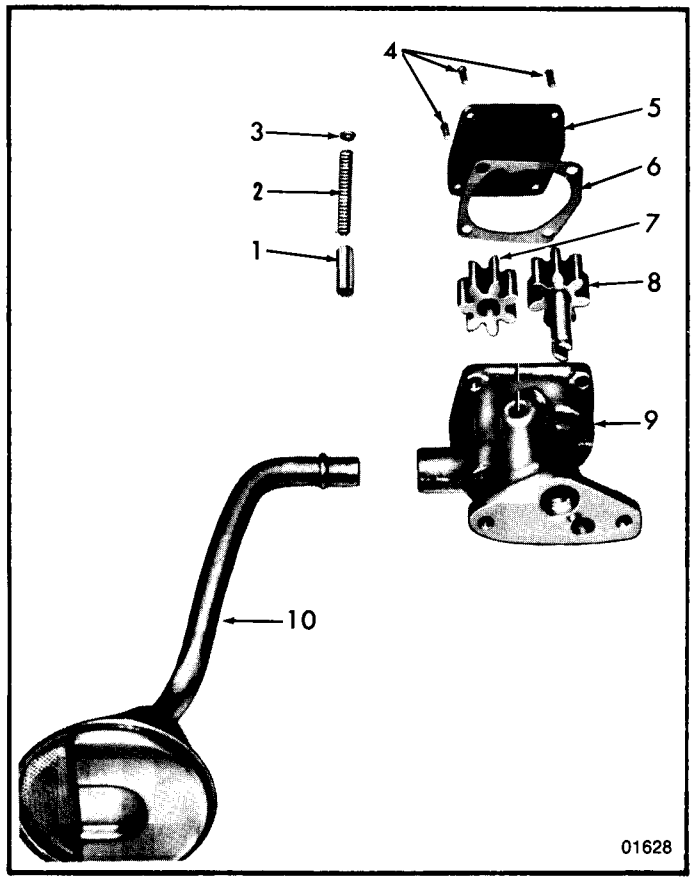
Reassembly

1. If pickup screen and pipe assembly was removed, replace with a new part. Loss of press fit condition could result in air leak and loss of oil pressure. Mount pump in soft-jawed vise and apply Perfect Seal to end of pipe with Tool J-8369. Tap pipe in place with plastic hammer.

⚠CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to bottom of oil pan when oil pump is installed.

2. Install pressure regulator valve spring and retaining pin.
3. Install drive gear and shaft in pump body.
4. Install idler gear in pump body with smooth side of gear toward pump cover opening, aligning teeth marked in disassembly.
5. Install pump cover with new gasket and torque attaching screws to specifications.
6. Turn drive shaft by hand to check for smooth operation.



1 - Pressure Regulator Valve
2 - Pressure Regulator Spring
3 - Retaining Pin
4 - Screws
5 - Pump Cover
6 - Cover Gasket
7 - Idler Gear
8 - Drive Gear and Shaft
9 - Pump Body
10 - Pickup Screen and Pipe

Oil Pump

Installation

1. Align oil pump drive shafts to match with distributor tang, then install oil pump to block, positioning flange over distributor lower bushing. Use no gasket.

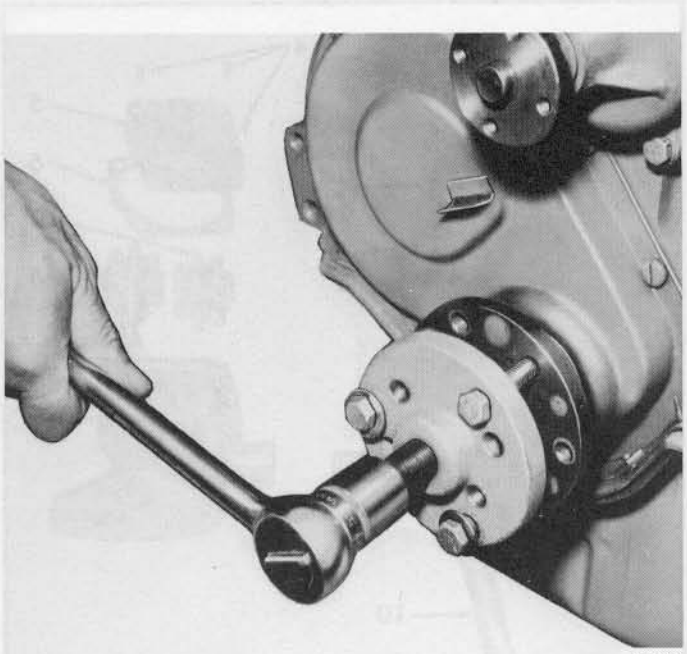
IMPORTANT: Oil pump should slide easily into place. If not, remove and reposition slot to align with distributor tang.

2. Install oil pump bolts and tighten securely.
3. Install oil pan.

Crankshaft Pulley (153 CID)

Removal

1. Support front of engine (if in boat) with overhead hoist.
2. Remove front mounting bracket and drive belt. Remove crankshaft pulley from pulley hub.
3. Install puller Tool J-6978-E to pulley hub and remove. Remove puller tool.



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Removing Crankshaft Pulley Hub

Installation

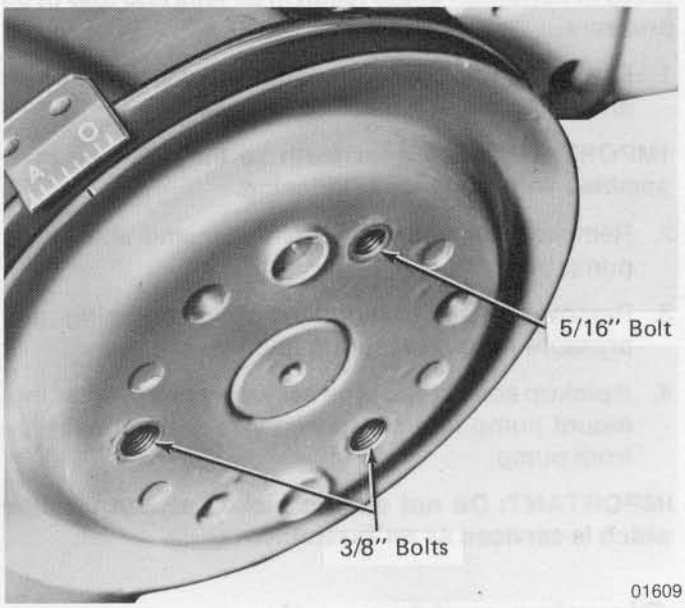
1. Coat oil seal lip with engine oil, position hub over crankshaft and key and start hub into position with a mallet. Using Tool J-5590, strike hub until it bottoms against crankshaft gear.

IMPORTANT: Crankshaft extends slightly thru hub, and a tool is necessary to drive hub completely into bottomed position.

2. Install pulley onto hub.

NOTE: There are two 3/8" holes and one 5/16" hole that must be matched on hub in order to properly position timing mark.

3. Install drive belt and adjust tension.
4. Install front mounting bracket.



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Install Pulley to Hub

Torsional Damper (181 CID)

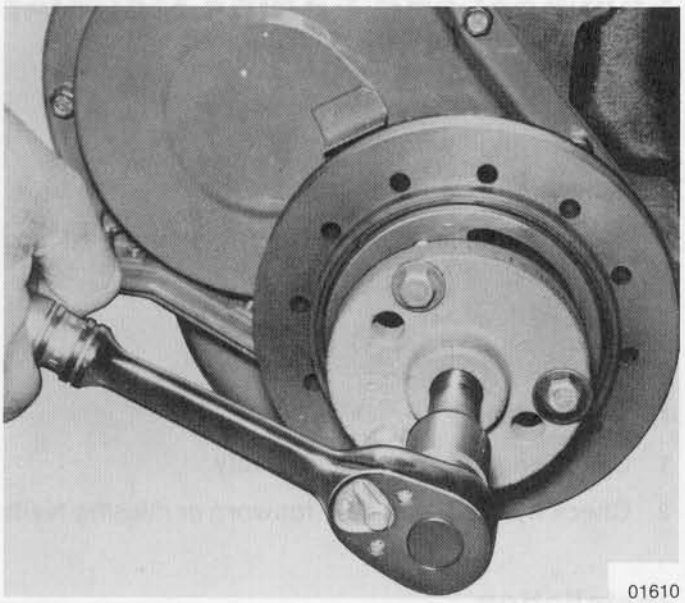
Removal

1. Support front of engine (if in boat) with overhead hoist.
2. Remove front mounting bracket and drive belt. (Remove retaining bolt, if so equipped.)
3. Install Tool J-6978-E to balancer and turn puller screw to remove damper. Remove tool from damper.

⚠CAUTION
Inertia weight section of torsional damper is assembled to hub with rubber type material. Installation procedures (with proper tool) must be followed or movement of inertia weight section on hub will upset tuning of torsional damper.

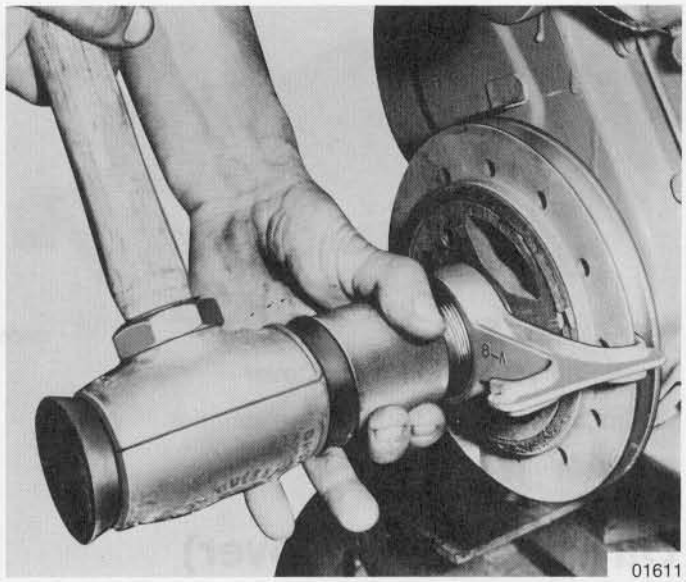
Installation

1. Coat front cover oil seal lip with engine oil.



Removing Harmonic Balancer

2. Attach damper installer Tool J-22197 to damper as shown.
3. Position damper on crankshaft and drive into position until it bottoms against crankshaft gear.
4. Remove installation tool.
5. Install drive belt and adjust tension.
6. Install front mounting bracket.



Installing Harmonic Balancer

Crankcase Front Cover

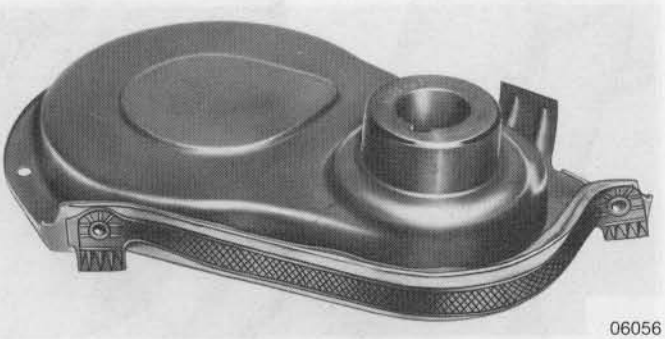
Removal

1. Remove oil pan.
2. Remove crankshaft pulley and hub or damper.
3. Remove crankshaft front cover attaching screws, cover and gasket.

Installation

1. Clean gasket surfaces on block and crankcase front cover.
2. Install centering Tool J-23042 in crankcase front cover seal.
3. Coat gasket with gasket sealer and place in position on cover, then install crankcase front cover to block and torque to specifications.
4. Remove centering tool.

IMPORTANT: Use only centering tool to align crankcase front cover so that crankshaft hub or damper installation will not damage seal and to position seal to seal evenly around damper or hub surface.



06056

Centering Tool (J-23042) In Cover

5. Install crankshaft hub and/or damper.
6. Install oil pan.

Oil Seal (Front Cover)

Replacement

With Cover Removed

1. With cover removed, pry old seal out of cover from front with large screwdriver.
2. Install new seal so that lip of seal is toward inside of engine and drive seal into position with Tool J-23042.

IMPORTANT: Support cover at sealing area.

Without Cover Removed

1. With crankshaft pulley and hub or damper removed, pry old seal out of cover from front with large screwdriver, being careful not to damage seal surface on crankshaft.
2. Install new seal so that lip of seal is toward inside of engine and drive seal into position with Tool J-23042.

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Installing Oil Seal (Cover Installed)

05031

Installing Oil Seal (Cover Installed)

Flywheel and Engine Coupler

Removal

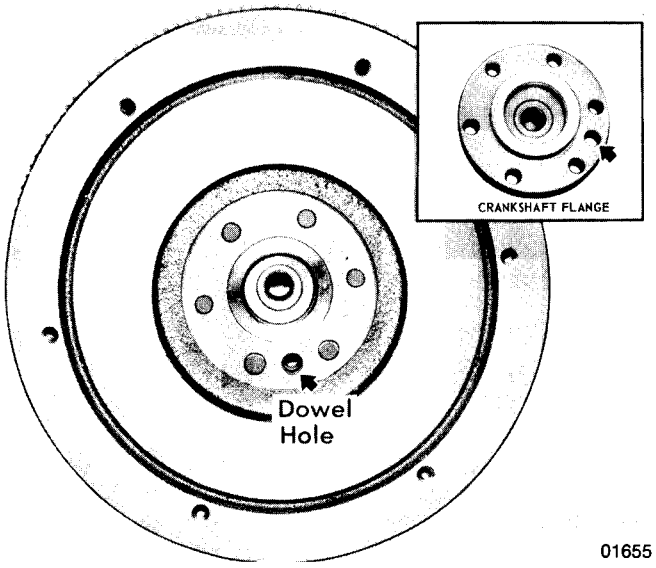
1. Remove engine from boat.
2. Remove bell housing.
3. Remove coupler by removing retaining nuts and washers.
4. Remove flywheel.

Inspection

1. Check engine coupling assembly.
2. Check flywheel ring gear for worn or missing teeth.

Installation

1. Install flywheel. Line up dowel hole in flywheel with dowel hole in crankshaft flange and set flywheel in place on studs.
2. Place drive coupling on studs and install washers and lock nuts. Torque nuts to specifications with Torque Wrench and Adaptor (91-35547).
3. Install bell housing.
4. Lubricate coupler splines with 2-4-C Marine Lubricant and install engine in boat.
5. Check engine alignment.



Flywheel Position on Crankshaft Flange

Oil Seal (Rear Main)

Replacement

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

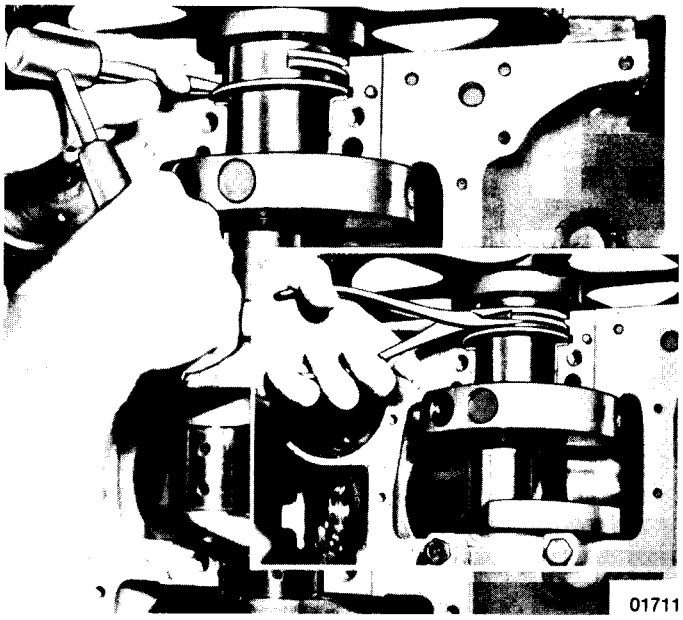
IMPORTANT: Always replace upper and lower seal as a unit. Install with lip facing toward front of engine. Where seal has 2 lips, install lip with helix toward front of engine.

1. With oil pan removed, remove rear main bearing cap.
2. Remove oil seal from rear main bearing cap by prying from bottom with small screwdriver.
3. Lubricate lip of new seal with engine oil. Keep oil off parting line surface, as this is treated with glue. Insert seal in cap and roll seal into place with finger and thumb, using light pressure so seal tangs at parting line do not cut bead on back of seal.

IMPORTANT: Later seals come with an installation tool. Follow instructions supplied with new seal.

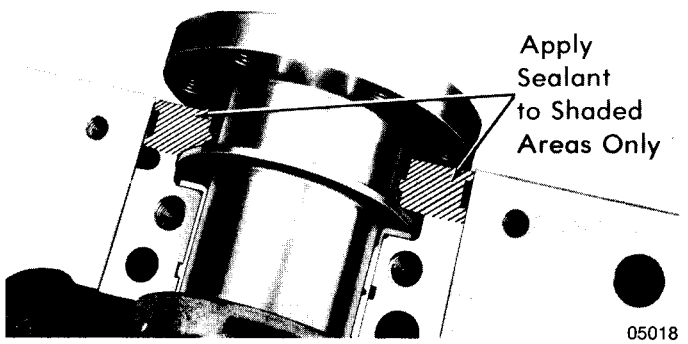
4. To remove upper half of seal, use small hammer and tap brass pin punch on one end of seal until it protrudes far enough to be removed with pliers.

IMPORTANT: Always wipe crankshaft surface clean before installing new seal.



Removing Oil Seal (Upper Half) Typical

5. Lubricate lip of new seal with engine oil. Keep oil off parting line surface. Gradually push with a hammer handle (while turning crankshaft) until seal is rolled into place (similar to installing a main bearing). Be careful that seal tangs at parting line do not cut bead on back of seal. Use sealer at parting line on rear main bearing cap half of seal.
6. Apply Perfect Seal to cylinder block in seal area.
7. Install rear main bearing cap (with new seal) and torque to specifications.
8. Install oil pan.



Sealing Bearing Cap and Block

Main Bearings

1. Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are found to be excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and undersize.
2. Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For example, one half of a standard insert with one half of a .001" undersize insert may be found, which will decrease clearance .0005" from using a full standard bearing.
3. When a production crankshaft cannot be precision fitted by this method, it then is ground .009" undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in same manner as previously described. Any engine, fitted with a .009" undersize crankshaft, will be identified by following markings.
   - ".009" will be stamped on crankshaft counterweight forward of centermain journal.
   - No. "9" will be stamped on block at left front oil pan rail.

Inspection

In general (except No. 1 bearing), lower half of bearing shows greater wear and most distress from fatigue. If, upon inspection, lower half is acceptable, it can be assumed that upper half also is satisfactory. If lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing other half. Typical bearing failures are shown under "General".

Checking Clearance

To obtain most accurate results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface.

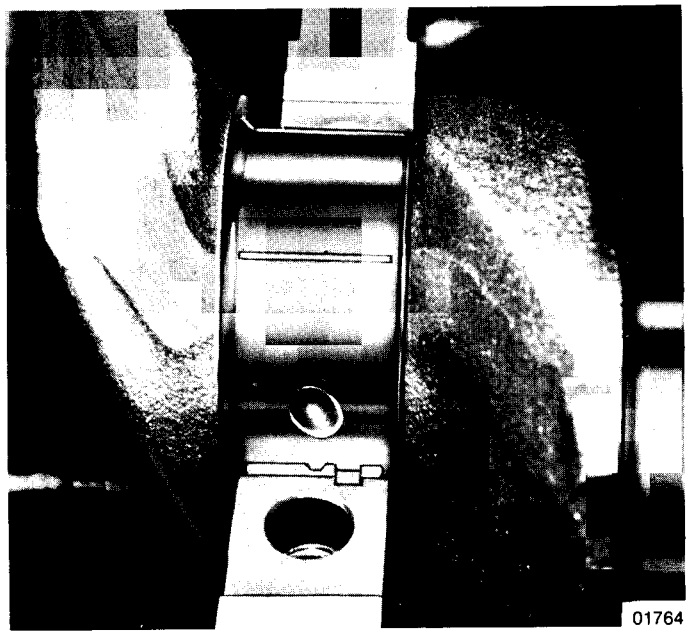
With engine upside down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

IMPORTANT: To assure proper seating of crankshaft, torque all bearing cap bolts as specified. In addition, before checking fit of bearings, wipe surface of crankshaft journal and face and back of bearing clean of oil.

1. Starting with rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place piece of gauging plastic the full width of bearing (parallel to crankshaft) on journal.

IMPORTANT: Do not rotate crankshaft while the gauging plastic is between bearing and journal.

3. Install bearing cap and evenly torque retaining bolts to specifications.
4. Remove bearing cap.
5. A graduated scale (correlated in thousandths of an inch) exists on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope.



Gauging Plastic on Journal

Measuring Gauging Plastic

IMPORTANT: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [.025mm] max.), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace insert. Always replace both upper and lower insert as a unit.
7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft so that no excessive drag exists.
9. Measure crankshaft end play as outlined under "Crankshaft".
10. Install new rear main bearing oil seal in cylinder block and main bearing cap.

Main Bearing Replacement

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct-size, main bearings with oil and install in cylinder block and main bearing caps. Check clearance.
4. Install crankshaft.

Connecting Rod Bearings

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and undersize.

Inspection and Replacement

1. Remove connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage. (Defective bearings should not be installed.) Typical bearing failures are shown under "General".
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with Plastigage or equivalent.

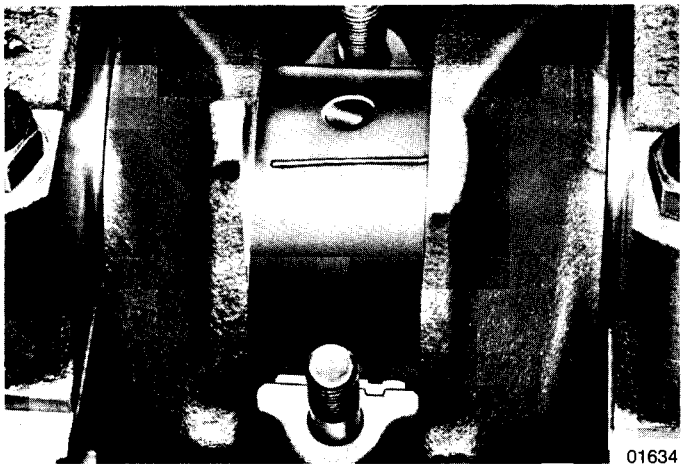
IMPORTANT: If bearing is being fitted to out-of-round crankpin, be sure to fit maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001", interference between bearing and crankpin will result in rapid bearing failure.

   a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft).
   b. Install bearing connecting rod and cap.
   c. Install bearing cap and torque nuts evenly to specifications.

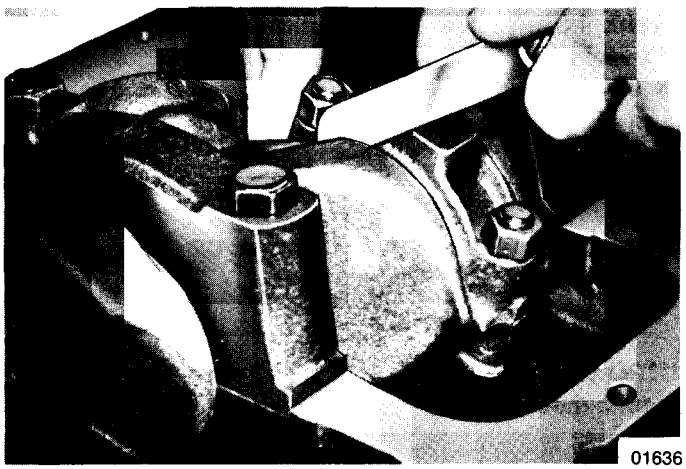
IMPORTANT: Do not turn crankshaft with gauging plastic installed.

   d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at widest point.

6. If clearance exceeds specifications, select a new, correct-size bearing and remeasure clearance.



Gauging Plastic on Crankpin



Measuring Connecting Rod Side Clearance

7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to be sure they have clearance.
9. Measure all connecting rod side clearances between connecting rod and side of crankpin.

Connecting Rod and Piston Assemblies

Removal

1. With oil pan, oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke and remove cloth and cuttings.

2. Inspect connecting rods and connecting rod caps for cylinder identification. If necessary, mark them.
3. Remove connecting rod cap and install Tool J-5239 (3/8"-24) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: It will be necessary to turn crankshaft slightly to disconnect some connecting rod and piston assemblies.

Disassembly (Method "1")

IMPORTANT: Piston cannot be reused using Method "1".

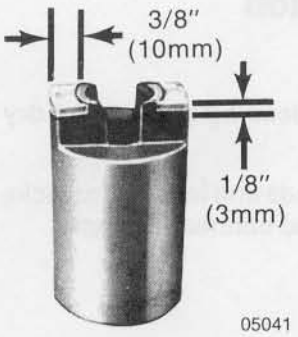
If bosses on pistons do not allow piston support Tool J-9510-1 to seat squarely on piston for press operations, modifications to tool are necessary. To allow adequate clearance for these bosses, turn or grind upper portion of tool to dimensions shown.

NOTE: Installation of 181 cubic inch pistons may require additional grinding of support tool beyond dimensions shown. Modification of tool, as described, does not affect tool application on other pistons.

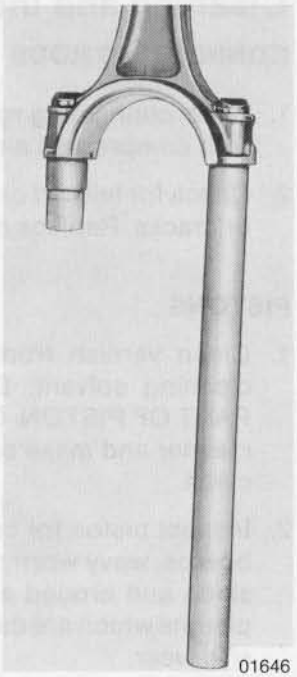
1. Remove connecting rod bearings from connecting rods and caps.

IMPORTANT: If connecting rod bearings are being reused, place in a rack for reinstallation in original rod and cap.

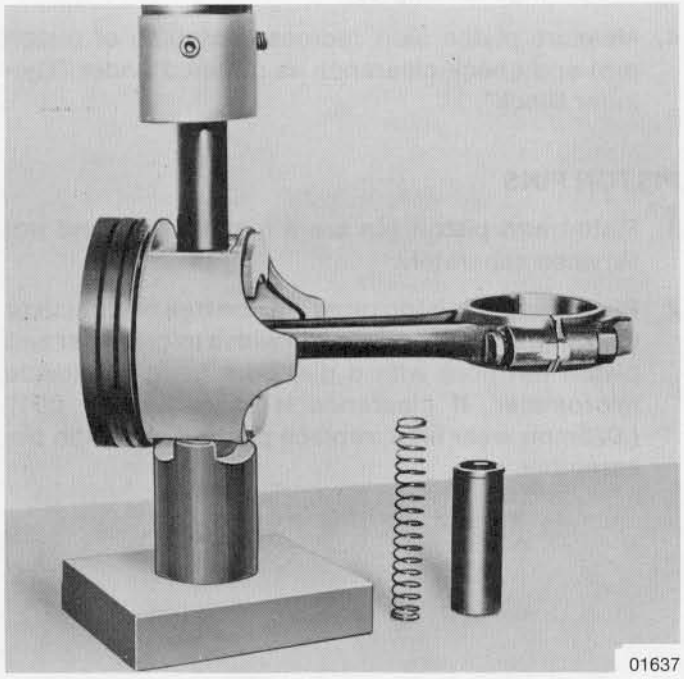
2. Use piston ring expander to expand rings and remove from pistons.
3. Place connecting rod and piston assembly in arbor press with piston on support Tool J-9510-1 and press piston pin out of connecting rod and piston.



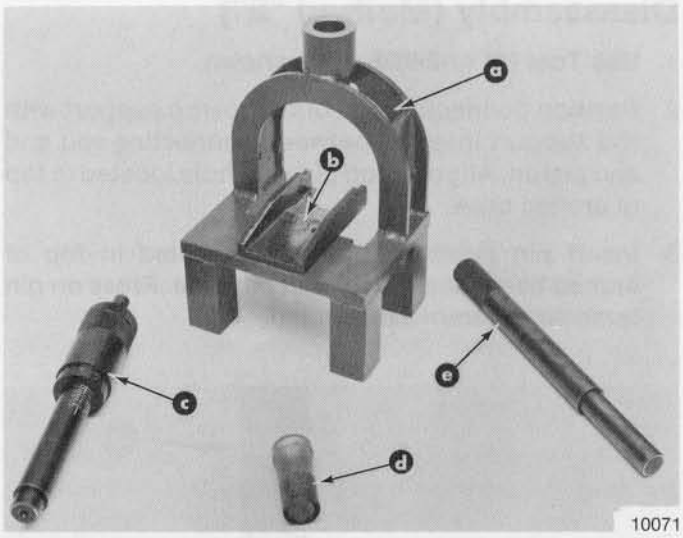
Guide Tool J-5239 Installed



Piston Support Tool J-9510-1



Removing Piston Pin

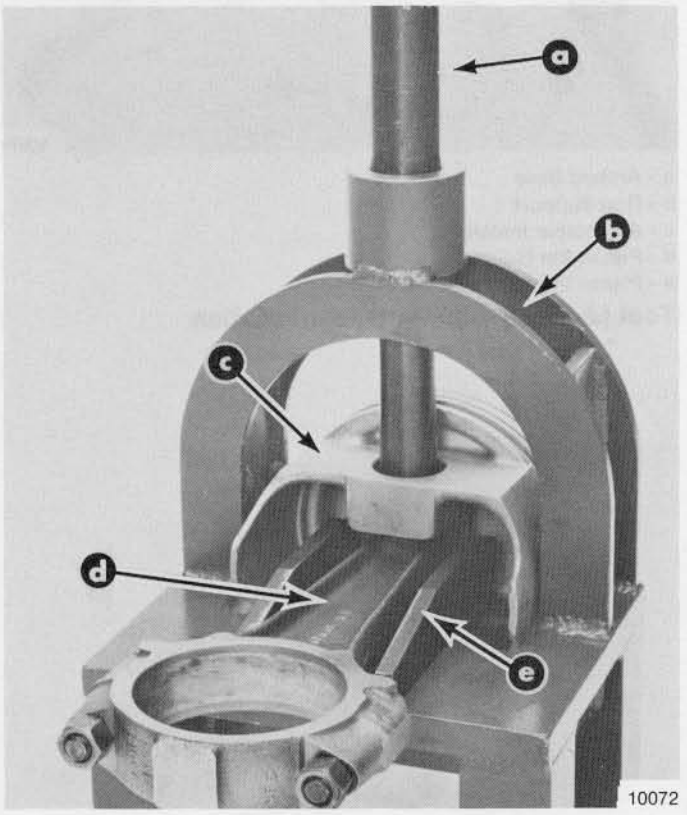


a - Arched Base
b - Rod Support
c - Adjustable Installer
d - Piston Pin Guide
e - Piston Pin Remover

Tool (J-24086-100) Parts Identification

Disassembly (Method "2")

1. Use Tool Kit (J-24086-100), shown.
2. Position connecting rod onto tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base.
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin.



a - Piston Pin Remover
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Removing Piston Pin

Cleaning and Inspection

CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

PISTONS

1. Clean varnish from piston skirts and pins with cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts and eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks or burrs which might cause rings to hang up.
4. Measure piston skirt (across centerline of piston pin) and check clearance as outlined under "Cylinder Block".

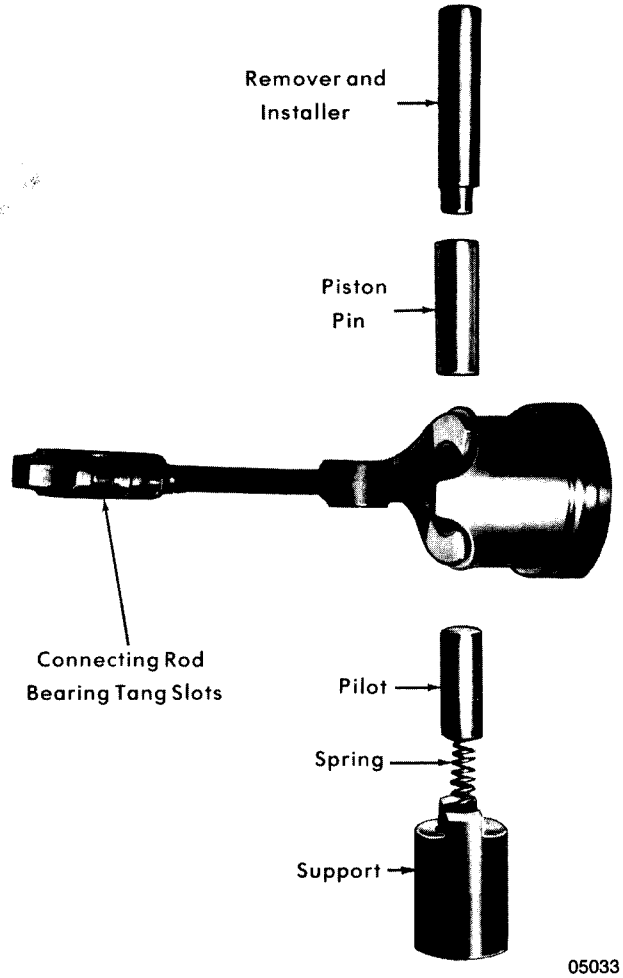
PISTON PINS

1. Piston and piston pin are a matched set and not serviced separately.
2. Pin bores and piston pins must be free of varnish or scuffing. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of .001" (.025mm) wear limit, replace piston and piston pin assembly.

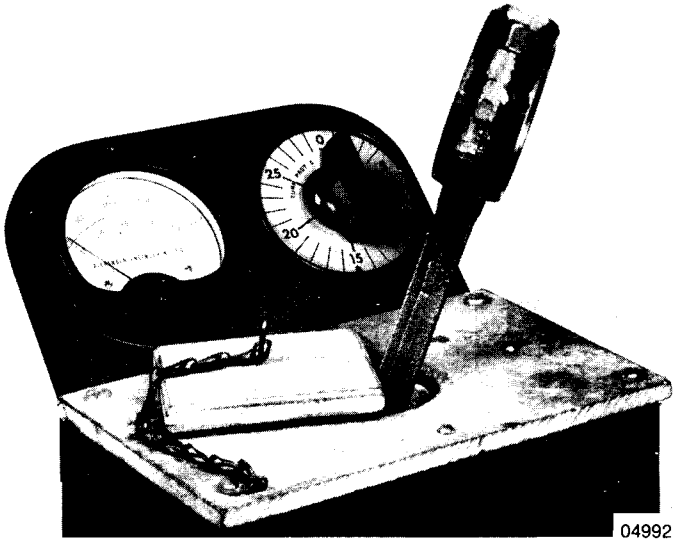
Reassembly (Method "1")

⚠CAUTION

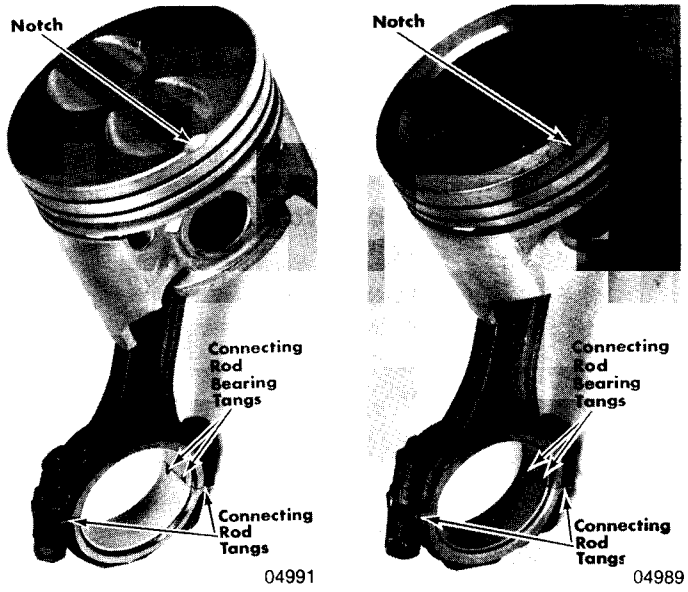
DO NOT oil piston pin or connecting rod before rod end is to be heated for installation.



Piston Pin Installation



Connecting Rod and Oven



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Connecting Rod and Piston Assembly

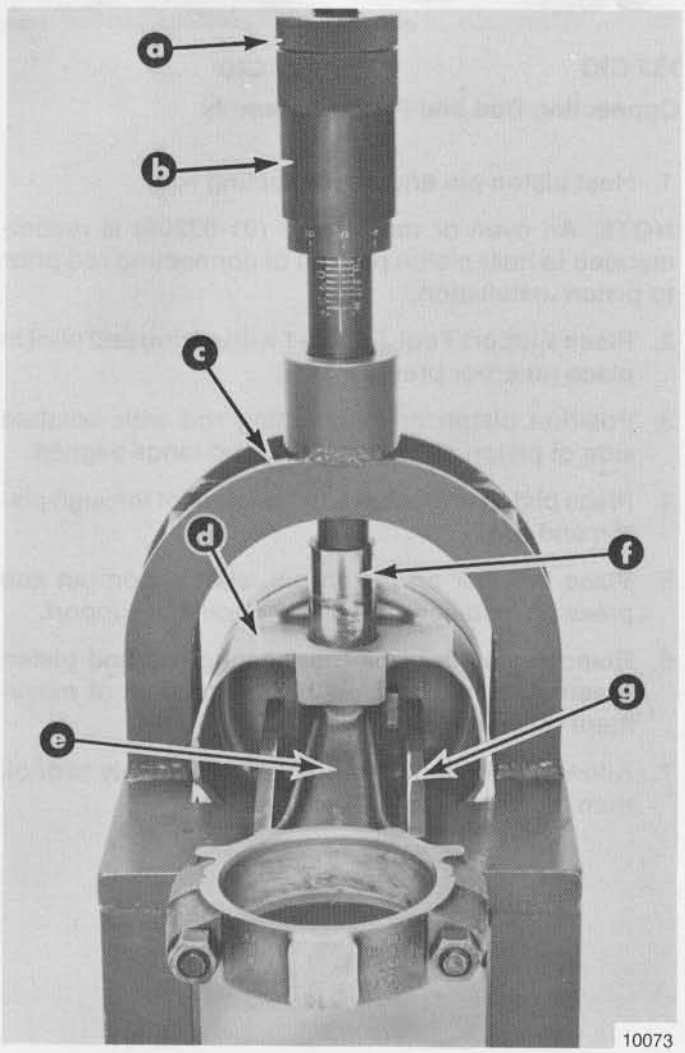
1. Heat piston pin end of connecting rod.

NOTE: An oven or torch lamp (91-63209) is recommended to heat piston pin end of connecting rod prior to piston installation.

2. Place support Tool J-9510-1 with spring and pilot in place on arbor press.
3. Position piston on connecting rod with notched side of piston and connecting rod tangs aligned.
4. Place piston on support, indexing pilot through piston and rod.
5. Place installer on piston pin, start piston pin and press on installer until pilot bottoms in support.
6. Remove installer from connecting rod and piston assembly and check piston for freedom of movement on piston pin.
7. Allow connecting rod and piston assembly to cool, then oil piston pin.

Reassembly (Method "2")

1. Lubricate piston pin, piston pin hole in piston and hole in rod end with a light coat of engine oil.
2. Position rod onto rod support and piston onto rod end. Insert piston pin guide thru bottom piston pin hole and into connecting rod. Place piston pin thru top side of piston.
3. Adjust adjustable installer to setting specified on chart (which came with tool) for particular piston installation. Lock adjustable installer with jam nut.
4. Insert adjustable installer thru hole (located on top of arched base) and into piston pin hole. Carefully press on adjustable installer until installer bottoms-out on arched base to install piston pin.

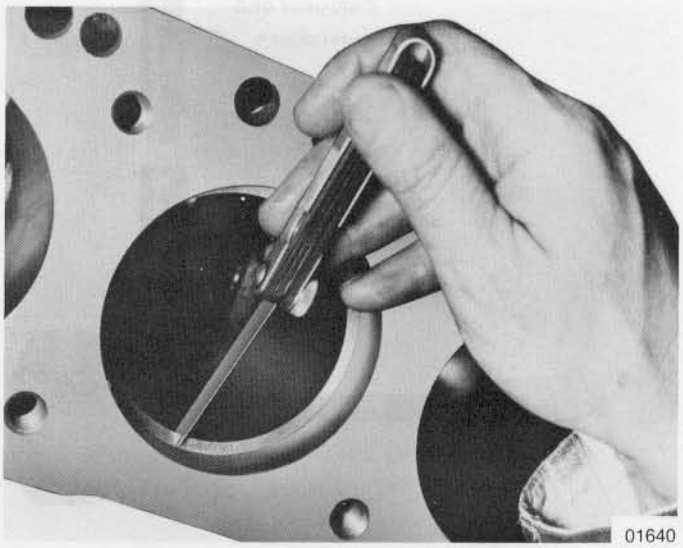


a - Jam Nut
b - Adjustable Installer
c - Arched Base
d - Piston
e - Connecting Rod
f - Piston Pin
g - Rod Support

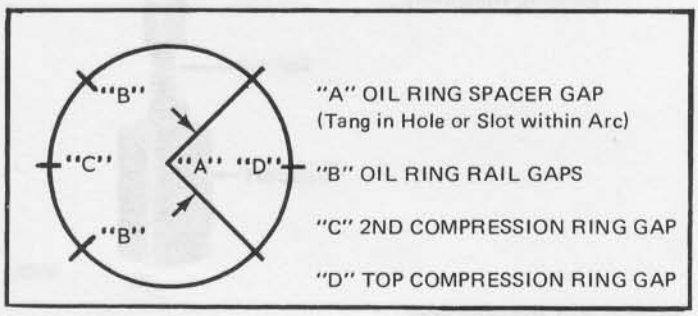
Installing Piston Pin

Piston Rings

All compression rings are marked on upper side of ring. When installing compression rings, make sure marked side is toward top of piston. Top ring is treated with molybdenum for maximum life. Oil control rings are 3-piece type, consisting of 2 segments (rails) and a spacer.



Measuring Ring Gap



Ring Gap Location

1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4" (6mm) (above ring travel). Be sure that ring is square with cylinder wall.
3. Measure space or gap between ends of ring with a feeler gauge.
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it will be used.
6. Clean and inspect pistons.

7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around groove to make sure that ring is free. If binding occurs at any point, determine cause and, if caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, use a new ring.
8. Install piston rings as shown.
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex oil ring assembly to make sure that ring is free. If binding occurs at any point, determine cause and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.
   e. Install second compression ring expander, then ring with gaps properly located.
   f. Install top compression ring with gap in correct location.
9. Proper clearance of piston ring in piston ring groove is necessary for proper ring action and to reduce wear. Therefore, when fitting new rings, measure clearances between ring surfaces and groove.

Installation

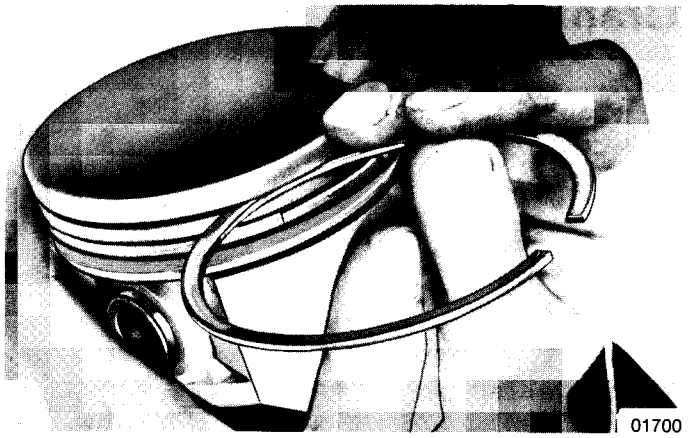
IMPORTANT: Cylinder bores must be clean before piston installation. Refer to Step 5, "Cylinder Block - Cylinder Honing."

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install Tool J-5239 (3/8") on connecting rod bolts.

⚠CAUTION

Be sure that ring gaps are properly positioned as previously outlined.

IMPORTANT: Early Model "181", No. 2 connecting rods have a ground recess on camshaft side to provide clearance for fuel pump lobe on camshaft. Be sure that No. 2 connecting rod is installed in same location and position. If connecting rod is replaced, then replace camshaft also, since replacement connecting rods are not ground for clearance, and replacement camshafts have a smaller fuel pump lobe.

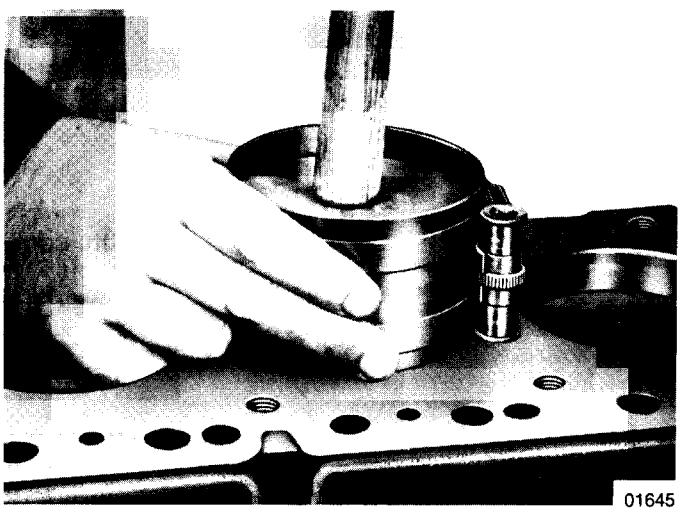


Checking Ring in Groove

4. Install each connecting rod and piston assembly in respective bore. Pistons must have piston notch facing front of engine. Use Tool J-8037 to compress rings. Guide connecting rod into place on crankshaft journal with Tool J-5239. Use light blows with hammer handle to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.
5. Remove guide tool.
6. Install bearing caps and torque nuts to specification.

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings".

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinders from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine.



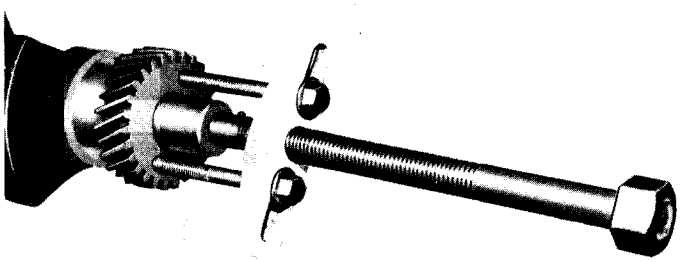
Installing Connecting Rod and Piston Assemblies

Crankshaft

Crankshaft can be removed while engine is disassembled for overhaul or without complete disassembly.

Removal

1. Remove flywheel housing, coupler and flywheel.
2. Remove starter motor.
3. Remove spark plugs.
4. Remove crankshaft pulley or torsional damper.
5. Remove oil pan and oil pump.
6. Remove crankcase front cover.
7. Check connecting rod caps for cylinder number identification. If necessary, mark caps.
8. Remove connecting rod caps and push pistons to top of bores.
9. Remove main bearing caps and lift crankshaft out of cylinder block.
10. Remove rear main bearing oil seal and main bearings from cylinder block and main bearing caps.
11. Remove crankshaft gear as shown.



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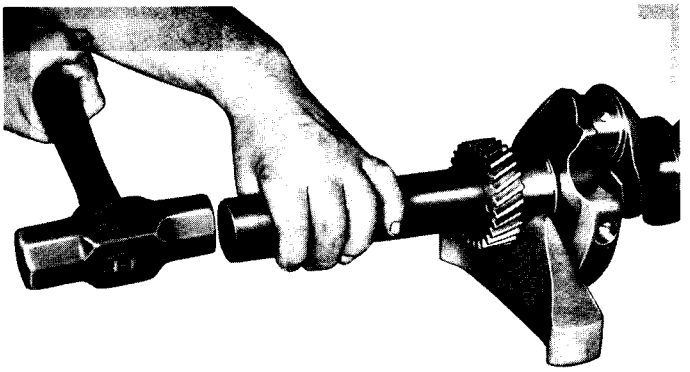
Removing Crankshaft Gear

Cleaning and Inspection

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of main bearing journals and crankpins with a micrometer for out-of-round, taper or undersize.
3. Check crankshaft for run-out by supporting at front and rear main bearing journals in "V" blocks and check at front and rear intermediate journals with a dial indicator.
4. Replace or recondition crankshaft if not within specifications.

Installation

1. Install crankshaft gear as shown.



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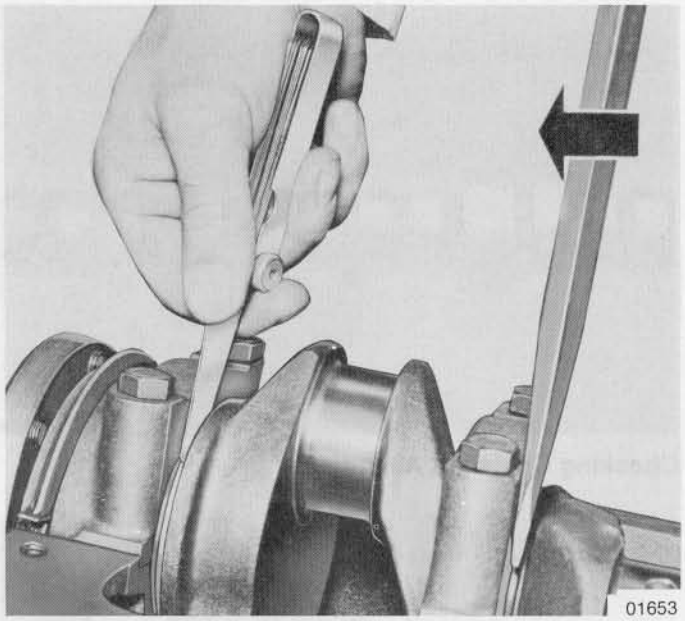
Installing Crankshaft Gear

2. Install crankshaft as follows:
   a. Install rear main bearing oil seal in cylinder block and rear main bearing cap grooves. Install with lip of seal toward inside of engine.
   b. Lubricate lip of seal with engine oil. Keep oil off parting line surface.
   c. Install main bearings in cylinder block and main bearing caps, then lubricate bearing surface with engine oil.
   d. Install crankshaft, being careful not to damage bearing surfaces.
   e. Apply a thin coat of Perfect Seal to block mating surface and corresponding surface of cap only. Do not allow sealer on crankshaft or seal lip.
   f. Install main bearing caps with arrows pointing toward front of engine.
   g. Torque all except rear main bearing cap bolts to 10-12 lbs. ft. (14-16 N.m). Torque rear main bearing cap bolts to specifications, then tap end of crankshaft, first from rear then forward, with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing cap bolts to specifications.
   h. Measure crankshaft end play with a feeler gauge. Force crankshaft forward and measure clearance between front of rear main bearing and crankshaft thrust surface.
3. Install connecting rod and caps.
4. Install crankcase front cover.
5. Install oil pump and oil pan.



Measuring Crankshaft End Play

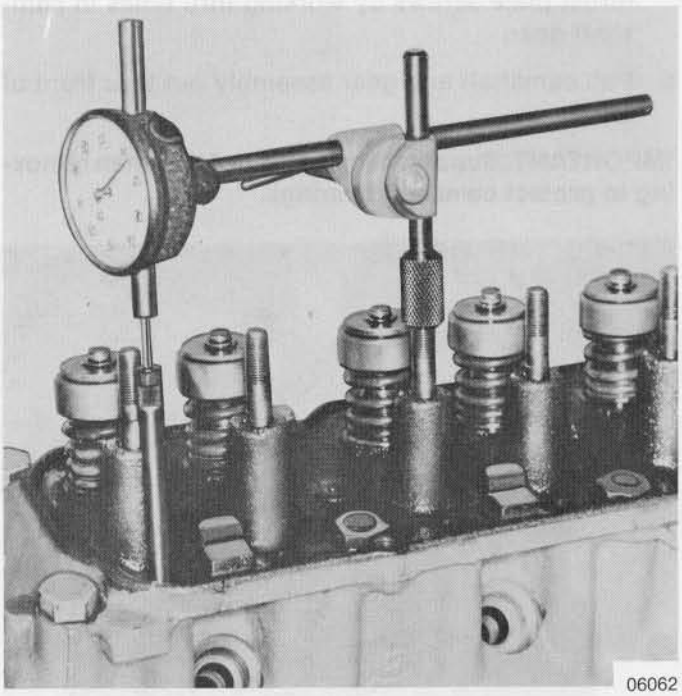
6. Install crankshaft pulley or torsional damper.
7. Install starter motor.
8. Install flywheel, coupler and flywheel housing.
9. Install spark plugs and torque to specifications.

Camshaft

Measuring Lobe Lift

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record the readings.

1. Remove valve mechanism.
2. Position indicator with ball socket adaptor (Tool J-8520) on push rod.
3. Rotate torsional damper slowly in direction of rotation until lifter is on lowest position of cam lobe.
4. Set dial indicator on zero, then rotate damper slowly, or attach an auxiliary starter switch and "bump" engine over, until push rod is in fully raised position.
5. Compare total lift recorded from dial indicator with "Specifications".
6. Continue to rotate crankshaft until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.

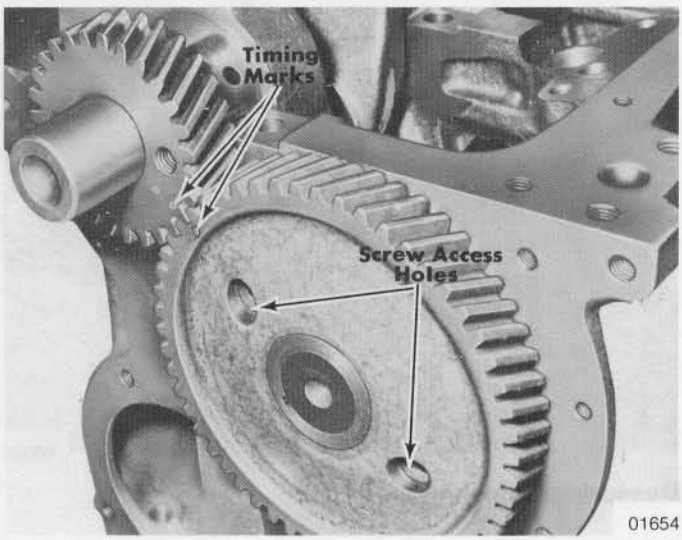


Measuring Camshaft Lobe Lift

Removal

1. Remove valve lifters.
2. Remove crankcase front cover.
3. Remove fuel pump.
4. Align timing gear marks, then remove 2 camshaft thrust plate screws by working thru holes in camshaft gear.
5. Pull camshaft and gear assembly out thru front of block.

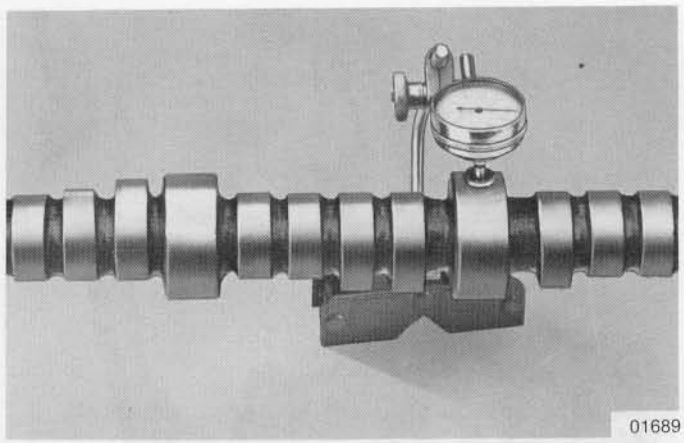
IMPORTANT: Support camshaft carefully when removing to protect camshaft bearings.



Timing Gear Marks

Inspection

1. Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" (.025mm) out-of-round, replace camshaft.
2. Check camshaft for alignment with "V" blocks and dial indicator for exact amount that camshaft is out-of-true. If out more than .002" (.05mm) dial indicator reading, replace camshaft.
3. Inspect camshaft gear and thrust plate for wear or damage. Measure camshaft end play [.001" to .005" (.03mm to .1mm)].



Checking Camshaft Alignment

Measuring Camshaft End Play

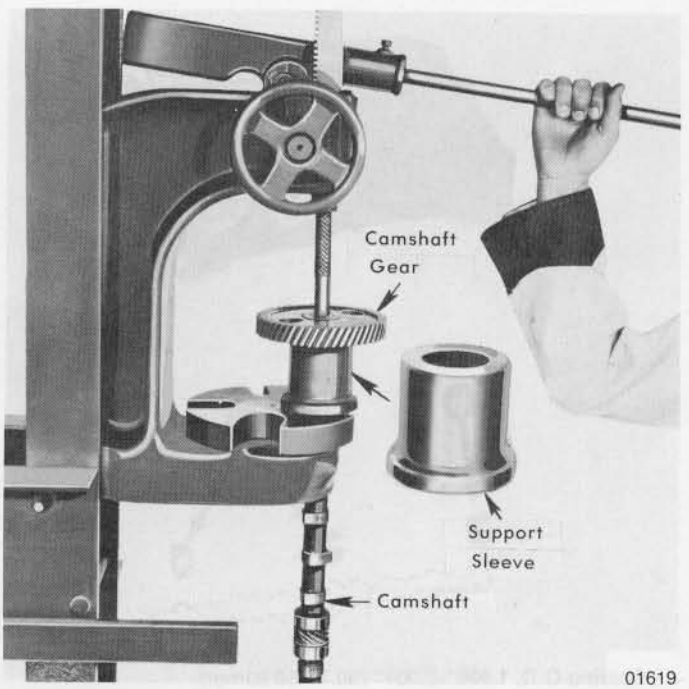
Camshaft Gear Replacement

1. If inspection (preceding) indicated that camshaft, gear or thrust plate should be replaced, remove gear from camshaft.
2. Place camshaft thru gear remover, place end of remover on table of a press and press shaft out of gear.

⚠CAUTION

Position thrust plate so that woodruff key in shaft does not damage plate when shaft is pressed out of gear. Also support hub of gear, or gear will be seriously damaged.

3. To assemble camshaft gear, thrust plate and gear spacer ring to camshaft, firmly support camshaft at back of front journal in arbor press.

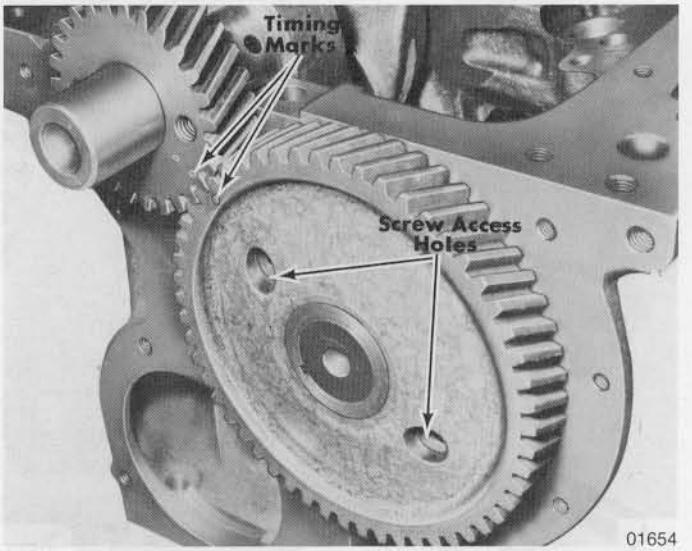


Removing Camshaft Gear

4. Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway. Press shaft gear onto shaft until it bottoms against gear spacer ring. End clearance of thrust plate should be .001" to .005" (.03mm to .1mm).

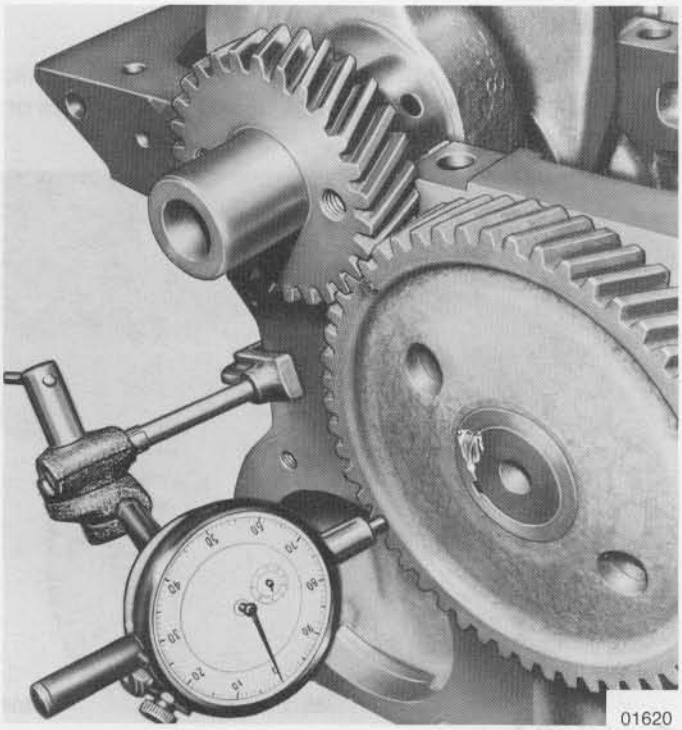
Installation

1. Install camshaft and gear assembly in engine block, being careful not to damage camshaft bearings or camshaft.

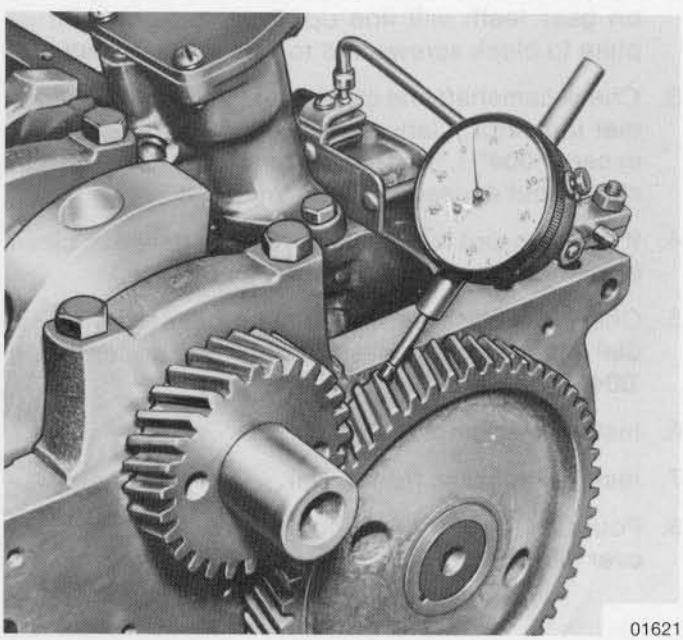


Crankshaft Gear

2. Turn crankshaft and camshaft so that timing marks on gear teeth will line up. Push camshaft thrust plate to block screws and torque to specifications.
3. Check camshaft and crankshaft gear run-out with a dial indicator. Camshaft gear run-out should not exceed .004" (.1mm) and crankshaft gear run-out should not exceed .003" (.07mm).
4. If gear run-out is excessive, remove gear and clean burrs from shaft, or gear must be replaced.
5. Check backlash between timing gear teeth with a dial indicator. Backlash should not be less than .004", nor more than .006" (.15mm).
6. Install fuel pump.
7. Install crankcase front cover.
8. Pour G.M. Engine Oil Supplement or light engine oil over camshaft lobes and install valve lifters.



Checking Timing Gear Run-Out



Checking Timing Gear Backlash

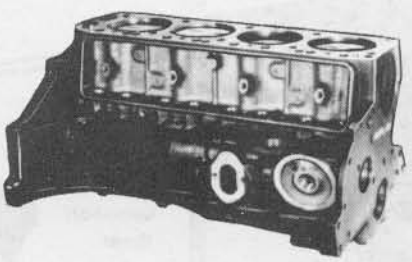
Camshaft Bearings

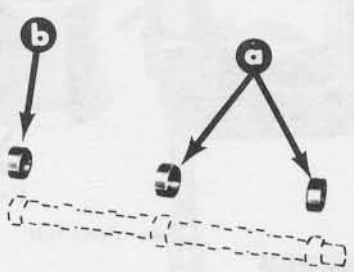
Removal

With camshaft removed, inspect bearings for evidence of wear or damage. Replace defective bearings.

Replace camshaft bearings while engine is disassembled for overhaul or without complete disassembly of the engine. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so that rods will not hinder camshaft bearing replacement.

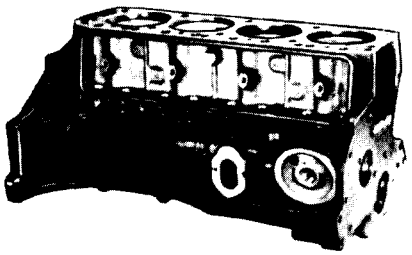
1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

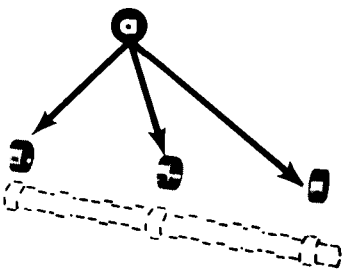




a - Bearing O.D. 1.999"-2.001" (50.77-50.83mm)
b - Bearing O.D. 2.009"-2.011" (51.03-51.08mm)

Use 23-85720 Bearing Set





a - Bearing O.D. 1.999"-2.001" (50.77-50.83mm)

Use 23-43293 Bearing Set

Camshaft Bearing O.D.

NOTE: This procedure is based on removal of bearings nearest center of engine first. Thus, a minimum number of turns are necessary to remove all bearings.

2. Using Tool Set J-6098-01, with nut and thrust washer installed to end of threads, position pilot in front camshaft bearing and install puller screw thru pilot.
3. Install remover and installer tool with shoulder toward bearing, making sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. Position pilot in rear camshaft bearing to remove rear intermediate bearing.
6. Assemble remover and installer tool on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.

Installation

Install front and rear camshaft bearings first. These bearings will act as guides for pilot and center remaining bearings being pulled into place.

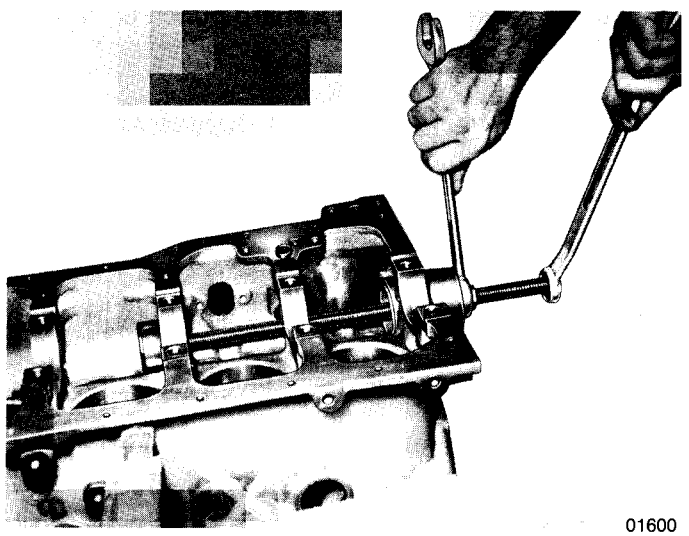
1. Assemble remover and installer tool on driver handle and install front and rear camshaft bearings by driving toward center of cylinder block.

⚠CAUTION

Oil holes in bearings must line up with oil holes in cylinder block. Oil hole is on top side of bearing shell and cannot be seen during installation, so first align bearing shell oil hole with oil hole in bore and mark opposite side of bearing and block at bore to easily position oil hole during installation.

IMPORTANT: Front bearing must be driven approximately 1/8" (3mm) behind front of cylinder block to uncover oil hole to timing gear oil nozzle.

2. Using Tool Set J-6098-01, with nut and thrust washer installed to end of threads, position pilot in front camshaft bearing and install puller screw thru pilot.



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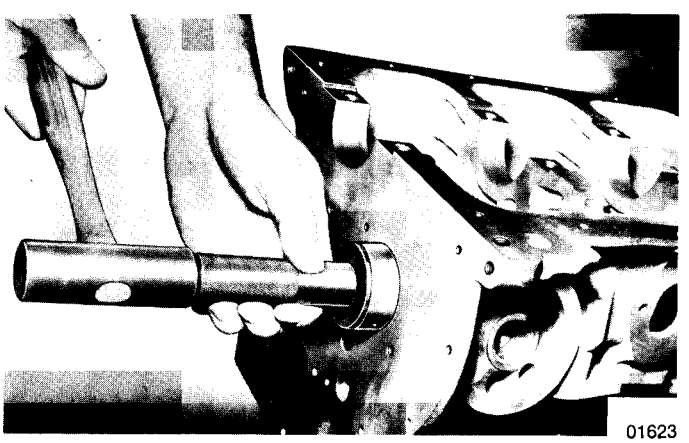
Pulling Bearing from Bore



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Removing and Installing Camshaft Bearings

3. Index camshaft bearing in bore, then install remover and installer tool on puller screw with shoulder toward bearings.
4. Using 2 wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove tool from puller screw and check alignment of oil hole in camshaft bearing.
5. Install remaining bearings in same manner. Position pilot in rear camshaft bearing to install rear intermediate bearing.
6. Install a new camshaft rear plug flush to 1/32" (.8mm) deep and parallel with rear surface of cylinder block. Use Perfect Seal on plug.

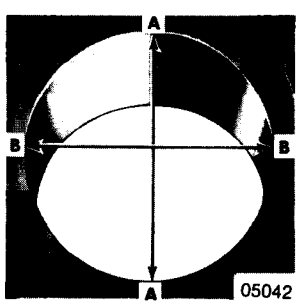
Cylinder Block

Cleaning and Inspection

1. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
2. Remove oil gallery plugs and clean all oil passages.

NOTE: Remove plugs with a sharp punch or drill and pry out.

"A" = At Right Angle to Centerline of Engine
"B" = Parallel to Centerline of Engine
Taper = Difference between "A" Measurement at Top of Cylinder Bore and "A" Measurement at Bottom of Cylinder Bore
Out-of-Round = Difference between "A" and "B"



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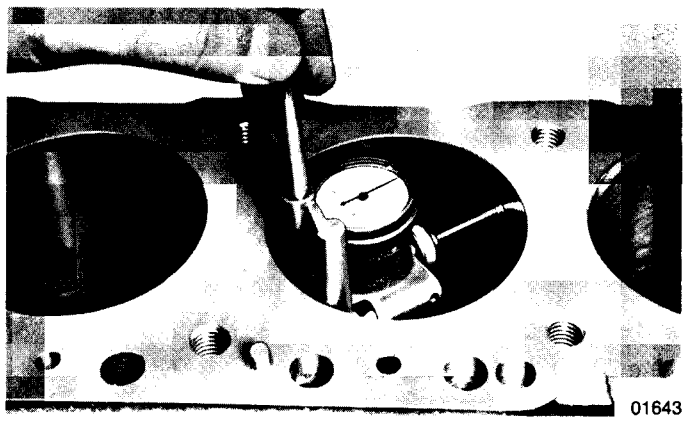
Cylinder Measurement

3. Clean and inspect water passages in cylinder block.
4. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
5. Measure the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel with dial indicator. Set gauge so that thrust pin must be forced in about 1/4" (6mm) to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "O". Carefully work gauge up-and-down cylinder to determine taper and turn gauge to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, honing and/or boring are necessary.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Measuring Cylinder Bore

Repairs

CYLINDER CONDITIONING

Condition of engine at time of repair is important. If inspection indicates that cylinder block is acceptable, except for out-of-round or tapered cylinders, condition the block by honing or boring.

If cylinders have less than .005" (.1mm) taper or wear, condition them with a hone and fit with high limit, standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. To clean up bore entirely, in such a case, rebore for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that permits complete resurfacing of all cylinders.

When pistons are fitted (honing no longer necessary), clean (scrub) cylinder bores with detergent and hot water. After cleaning, swab cylinder bores several times with light engine oil with clean cloth, then wipe with clean, dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This will guard against a tilted boring bar and assures that rebored cylinder wall is at right angles to crankshaft.
2. Measure piston, to be fitted, with a micrometer at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone cylinder to specifications and as outlined under "Cylinder Honing" and "Piston Selection".
3. Carefully follow instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish honing a cylinder bore to fit a piston, move hone up-and-down to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 30° to cylinder bore. Finish marks should be clean but not sharp and free from imbedded particles and torn or folded metal.

⚠CAUTION

Handle pistons with care and do not attempt to force them thru cylinder until cylinder has been honed to correct size, as this type piston can be distorted thru careless handling.

4. Permanently mark piston for cylinder to which it has been fitted and proceed to hone cylinders and fit remaining pistons.
5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. Be absolutely certain that no abrasive material is allowed to remain in cylinder bores, or it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by contaminated oil. Swab bores several times with light engine oil with a clean cloth, then wipe with a clean, dry cloth. DO NOT clean cylinder with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

Piston Selection

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "Cylinder Bore Diameter" with a telescope gauge [2-1/2" (64mm) from top of cylinder bore].
   b. Measure "Piston Diameter" (at skirt across centerline of piston pin).
   c. Subtract piston diameter from cylinder bore diameter to determine "Piston to Bore Clearance".
   d. Determine if piston to bore clearance is in acceptable range.
2. If piston to bore clearance is not acceptable, check Parts Manual for oversize pistons.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance.
4. Mark piston to identify cylinder for which it was fitted.

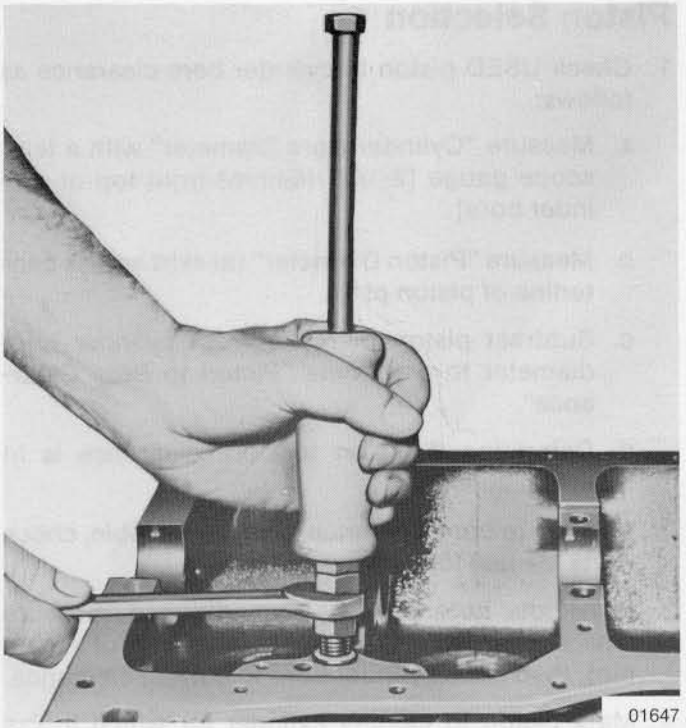
Distributor Lower Bushing

Inspection and Replacement

Distributor lower bearing is a bronze bushing pressed into lower side of engine block. Its upper inside diameter pilots distributor shaft, and outside diameter (extending below block) pilots oil pump.

Some engines have a thrust washer at upper end of bushing bore. Thrust washer, where used, may be replaced at same time bushing is replaced.

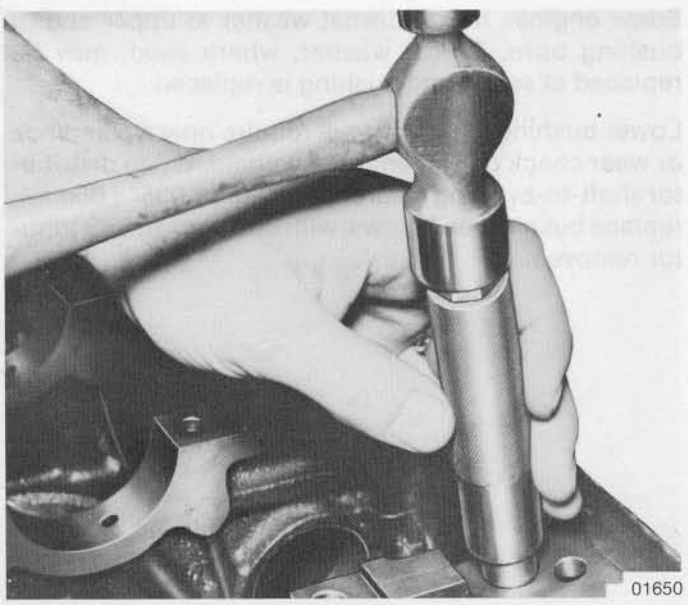
Lower bushing ordinarily will require only a clearance or wear check during engine overhaul. When distributor shaft-to-bushing clearance exceeds .035" (.08mm), replace bushing, as follows, with oil pump and distributor removed:



Removing Distributor Lower Bearing

IMPORTANT: Later distributors use a bushing in distributor housing. Measuring clearance between cylinder block bushing and distributor shaft is not needed, since shaft is undercut.

1. Install Tool J-9534-01 into bushing and remove bushing with a slide hammer.
2. Clean bushing bore in block and check for burrs or damage.



Install Distributor Lower Bearing

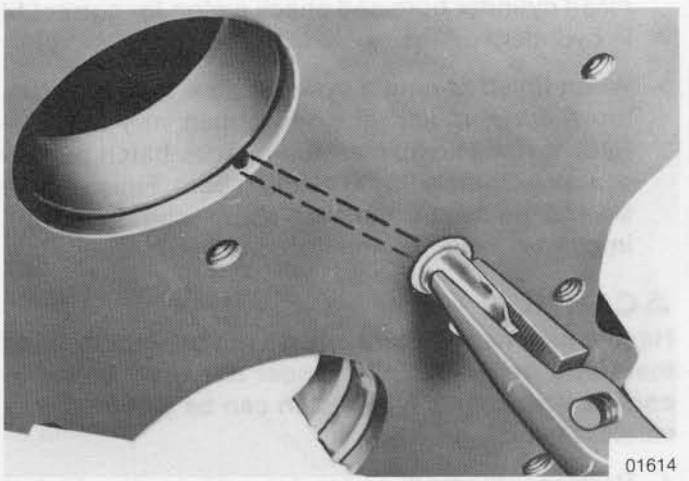
3. Use tool with driver-bolt in driver handle to install driver into new bushing from large inside diameter.
4. Position bushing and driver to block and drive bushing in position, which is determined by tool bottoming against block.
5. Remove tool from bushing. It is possible that bushing with minimum inside diameter will collapse enough during installation to slightly seize installer arbor. If this happens, remove installer tool with slide hammer in driver bolt hole of driver handle.

NOTE: This will not damage bushing, and tool is designed for this purpose, should it occur.

Oil Nozzle Replacement

1. Remove nozzle with pliers.
2. Drive new nozzle in place (oil hole in vertical position) with a suitable light plastic or rubber hammer.

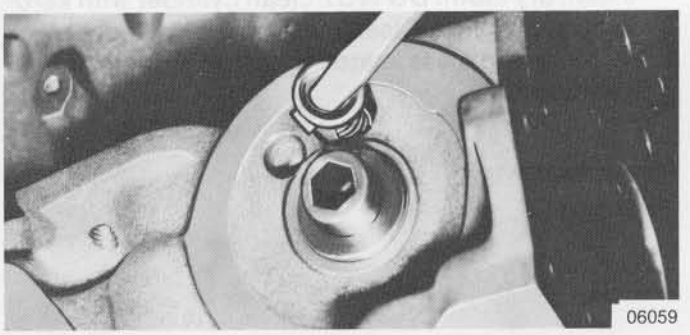
NOTE: Later model engines DO NOT have an oil nozzle. A plug is used to seal this hole.



Oil Nozzle Replacement

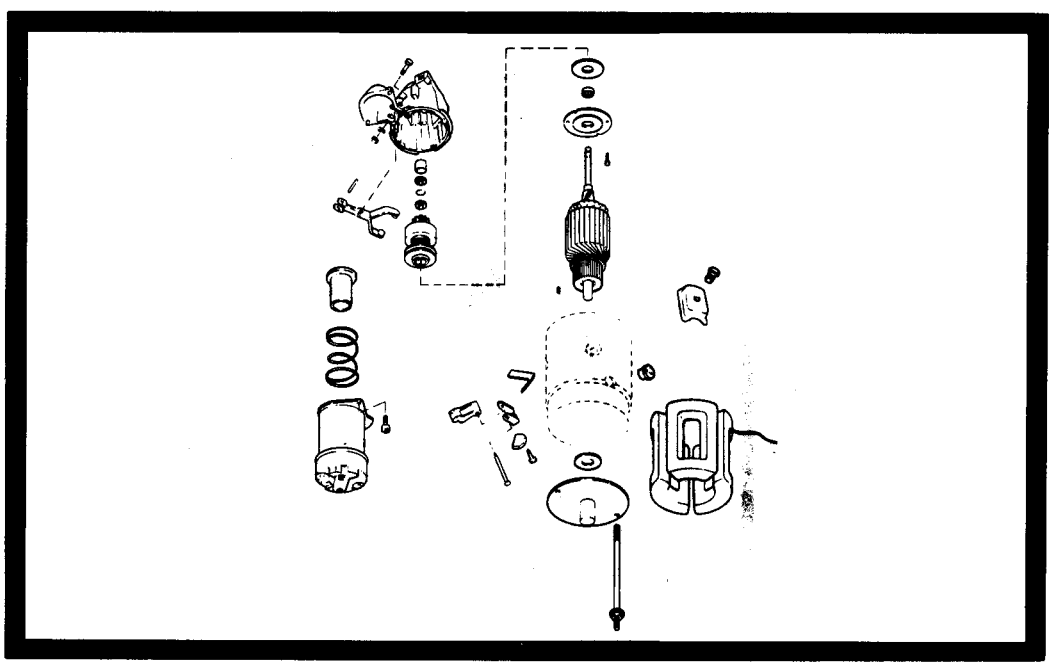
Oil Filter Bypass Valve and Replacement

With oil filter removed, check spring and fiber valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, pry valve out with screwdriver. Install and seat a new valve by tapping in place with a 9/16 thin-wall deep socket.



Oil Filter By-Pass Valve

ELECTRICAL SYSTEM



4

A

STARTING SYSTEM

mercruiser
STERN DRIVES & INBOARDS

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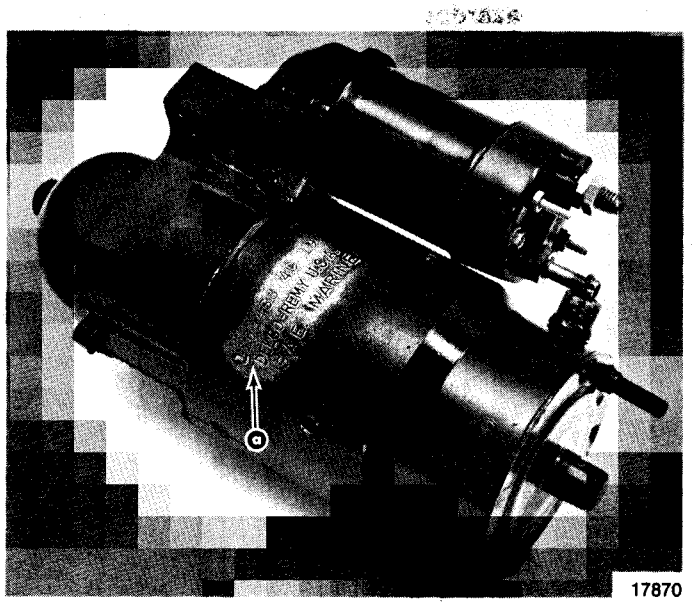
Starter Identification



a - Delco Number

Delco-Remy Starter Motor

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Battery

Size Recommendation

BATTERY COLD CRANKING AMPERAGE
375 / 90 Ah
MCM 120/2.5L 140/3.0L

Cable Size

IMPORTANT: Terminals MUST BE soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder ONLY. DO NOT use acid flux solder, as it may cause corrosion and failure.

BATTERY CABLE	
Cable Length	**Cable Gauge**
Up to 3-1/2 Ft. (1.1m)	4 (19mm²)
3-1/2 - 6 Ft. (1.1-1.8m)	2 (32mm²)
6 - 7-1/2 Ft. (1.8-2.3m)	1 (40mm²)
7-1/2 - 9-1/2 Ft. (2.3-2.9m)	0 (50mm²)
9-1/2 - 12 Ft. (2.9-3.7m)	00 (62mm²)
12 - 15 Ft. (3.7-4.6m)	000 (81mm²)
15 - 19 Ft. (4.6-5.8m)	0000 (103mm²)
Both positive (+) and negative (-) cables	

Precautions

⚠WARNING

Hydrogen gases that escape from the battery during charging are explosive. Be sure that battery area is well ventilated and that bilge blower is in operation when charging. DO NOT smoke or allow sources of spark or open flame in area when charging battery.

⚠WARNING

Battery electrolyte is a corrosive acid and should be handled with extreme care. If electrolyte is spilled or splashed on any part of the body, IMMEDIATELY flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible. Safety glasses and rubber gloves are recommended when handling batteries.

⚠CAUTION

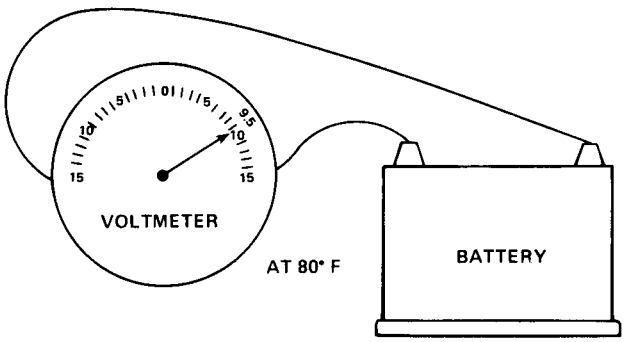
To prevent damage to the electrical system be sure to adhere to the following:

- **When installing battery, be sure to connect the (-) negative (grounded) battery cable to the (-) negative battery terminal and (+) positive battery cable to (+) positive battery terminal.**
- **Never disconnect the battery cables while the engine is running.**
- **If a charger or booster is to be used, BE SURE to connect it in parallel with existing battery (positive to positive and negative to negative).**
- **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**
- **Check battery condition periodically.**
- **Make sure that battery leads are kept clean and tight.**

Testing

LOAD TEST

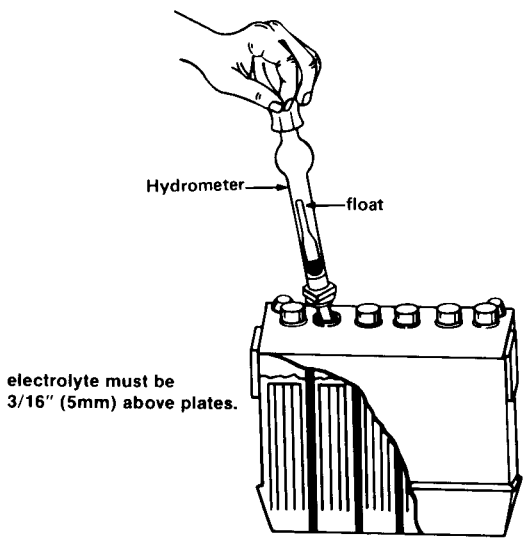
A strong battery must be maintained. If battery shows less than 9-1/2 volts when under starting load, it should be recharged. Check with DC voltmeter.



HYDROMETER TEST

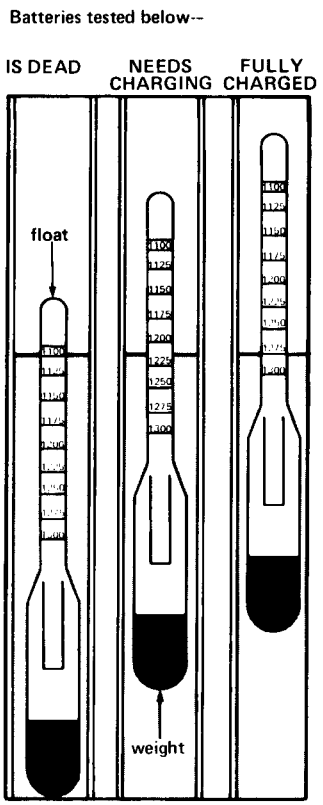
When using a hydrometer, observe the following points:

1. Hydrometer must be clean (inside and out) to insure an accurate reading.
2. Never take hydrometer readings immediately after water has been added.
3. If hydrometer has built-in thermometer, draw liquid in several times to ensure correct temperature before taking reading.
4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free-floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid.
5. Avoid dropping electrolyte on boat or clothing, as it is extremely corrosive. Wash off immediately with baking soda solution.



⚠WARNING

Test battery in well ventilated area as gases given off by battery are hazardous.



It is the activity of the acid (hyd. reading) which determines the activity of that cell.

Fully Charged	1.280	1.260
75% Charged	1.230	1.220
50% Charged	1.180	1.170
25% Charged	1.130	1.120
Discharged	1.080	1.070

Storage

- Remove battery and clean exterior.
- Check fluid level and fill if low.
- Cover terminals and bolts with light coat of grease.
- Set battery on wood or in carton, store in cool, dry place.
- Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

Charging Guide

12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition

Twenty Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 Ampere-Hours or Less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/4 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

*Initial rate for constant voltage taper rate charger

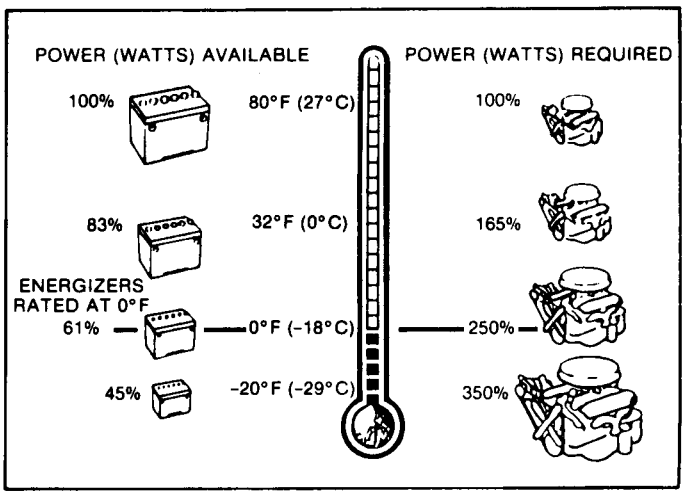
To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125° F (52° C).
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

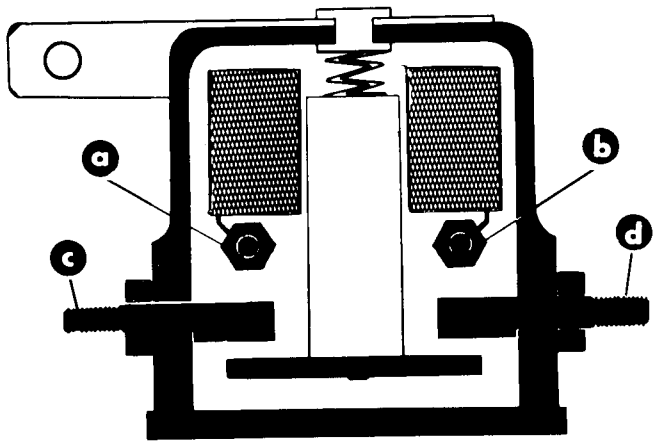
Battery Power as Affected by Temperature



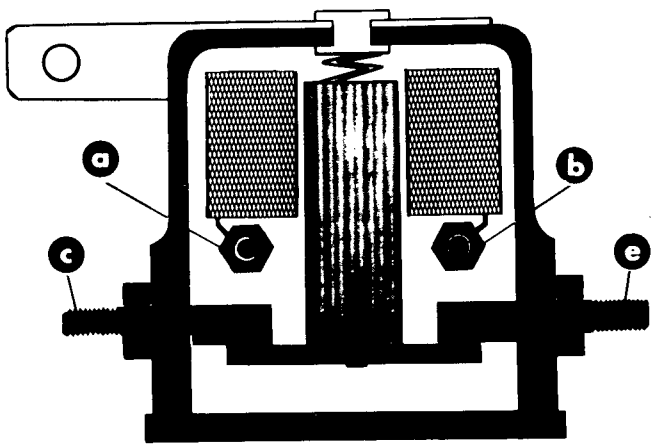
Slave Solenoids

Types

There are two ("standard" or "switch") types of slave solenoids used on MerCruiser engines. MCM/MIE 470 and MCM 485 engines (with Prestolite starter motors) use a "switch type" slave solenoid as a starter solenoid. The other engines use a slave solenoid to energize the starter motor solenoid. Some model engines use the small terminal on the "switch type" solenoid for ignition by-pass during the starting of the engine. Because of this, be sure to use correct type of slave solenoid for replacement.



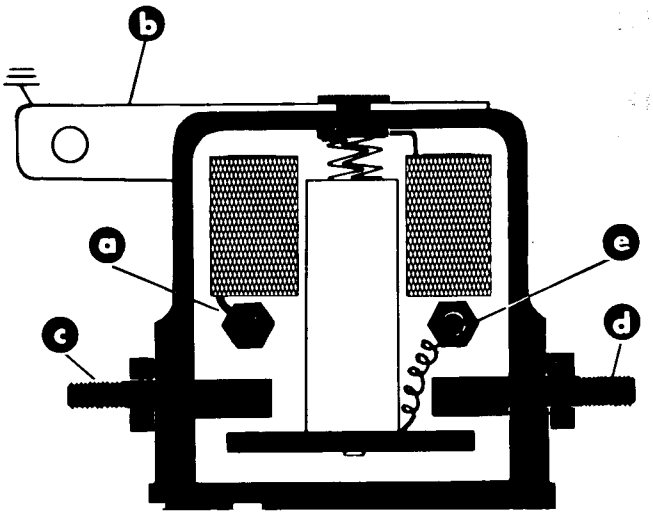
OFF or RUN
POSITION



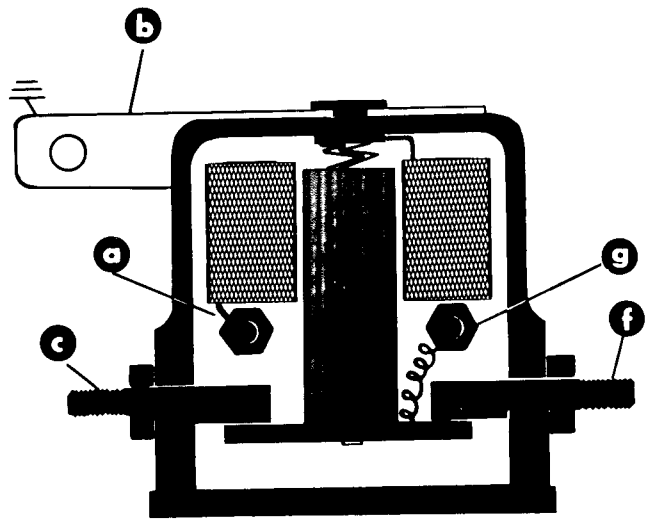
START
POSITION

a - From Key Switch (12 Volts in Start Position)
b - To Ground
c - 12 Volts From Battery
d - 0 Volts To Starter
e - 12 Volts To Starter

"Standard Type" Slave Solenoid



OFF or RUN
POSITION



START
POSITION

a - From Key Switch (12 Volts in Start Position)
b - Mounting Bracket and Ground
c - 12 Volts From Battery
d - 0 Volts To Starter
e - 0 Volts To Ignition Coil
f - 12 Volts To Starter
g - 12 Volts To Ignition Coil

"Switch Type" Slave Solenoid

Testing

1. Disconnect battery cables, then remove all wires from solenoid terminals.
2. Remove solenoid.
3. **Standard Type**
   a. Connect continuity meter to large terminals.
   b. Connect jumper wire from positive (+) terminal on 12 volt battery to "a" terminal on solenoid.
   c. Connect jumper wire from negative (-) terminal of battery to "b" terminal on solenoid.
   d. If meter does not move, replace solenoid.

   Switch Type

   a. Connect continuity meter to large terminals.
   b. Connect jumper wire from positive (+) terminal on 12 volt battery to "a" terminal on solenoid.
   c. Connect jumper wire from negative (-) terminal of battery to "b" mounting bracket.
   d. If meter does not move, replace solenoid.
   e. To test ignition by-pass, move meter lead from "f" terminal to "g" terminal. If meter does not move, replace solenoid.
4. Install solenoid.
5. Reconnect wires to terminals. Tighten securely and coat with Liquid Neoprene.
6. Reconnect battery cables. Tighten securely.

Delco-Remy Starter Motor

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Starter End Cap		110 (12)
Starter to Block	50 (68)	

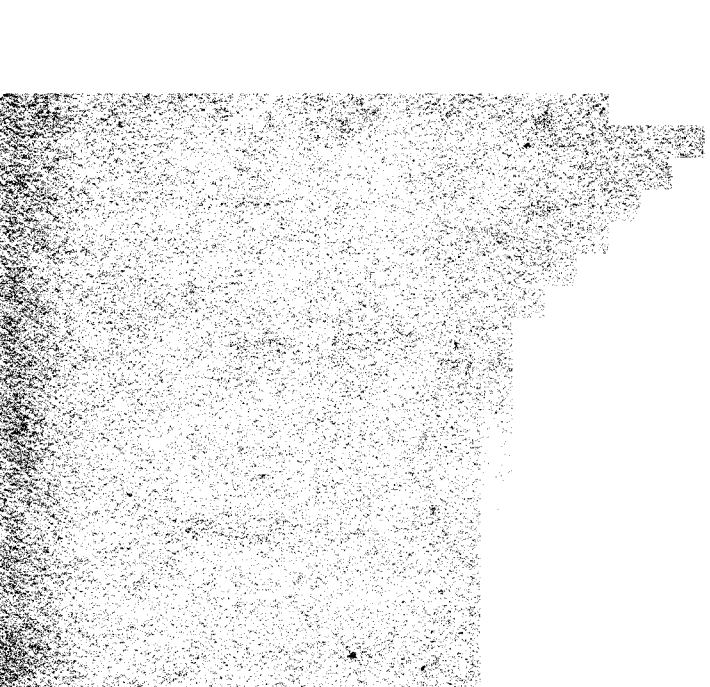
Lubricants/Sealants

LUBRICANTS/SEALANTS	
92-25711-2	Quicksilver Liquid Neoprene
92-34227-1	Quicksilver Perfect Seal
	SAE 10W Oil
	SAE 20W Oil

Specifications

DELCO IDENTIFICATION NUMBER	ENGINE ROTATION	NO LOAD TEST					BRUSH SPRING TENSION OZ. (GRAMS)
		VOLTS	MIN. AMPS	MAX. AMPS	MIN. RPM	MAX. RPM	
1998317	L.H.	10.6	70	120	5400	10,800	56-105 (1588-2976)
PINION CLEARANCE							.010 - .140 (.25 - 3.5mm)
COMMUTATOR END FRAME GAP							.025 MAX. (.6mm MAX.)

L.H. = LEFT HAND ENGINE ROTATION
R.H. = RIGHT HAND ENGINE ROTATION



Notice

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

Removal

⚠WARNING
Disconnect battery cables at battery before removing starter.

1. Disconnect wires from solenoid terminals.
2. Remove starter mounting bolts.
3. Pull starter assembly away from flywheel and remove from engine.

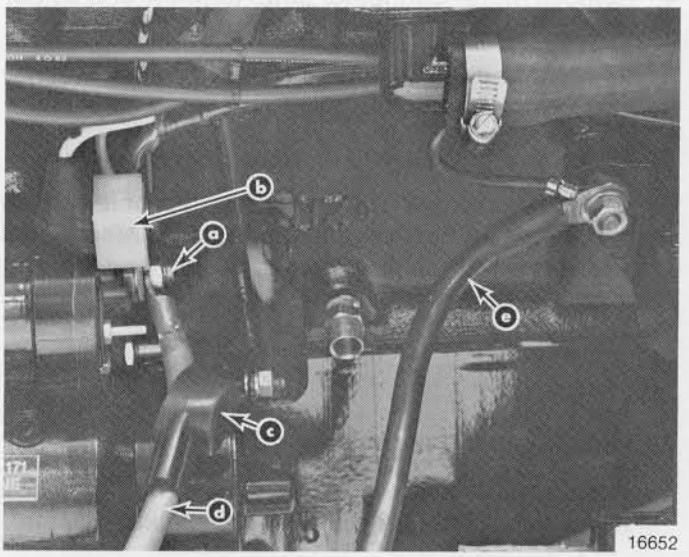
IMPORTANT: Some starter motors may have a special shim between mounting surface. DO NOT lose this shim.

Installation

1. Place starter assembly in position and install mounting bolts. Torque fasteners to specifications.

IMPORTANT: Install special shim (if equipped) between starter motor and block.

2. Connect wires to solenoid terminals.
3. Connect red battery cable to large solenoid terminal and install boot over terminal (if equipped).
4. Connect battery cables to battery.



a - Large Terminal
b - Fuse (If Equipped)
c - Boot (If Equipped, Place Over Terminal)
d - Positive (+) Battery Cable
e - Negative (-) Battery Cable

Typical Starter Motor

Solenoid

Removal

1. Remove starter motor as outlined.
2. Remove screw and washer from starter motor connector strap terminal.
3. Remove 2 screws which hold solenoid assembly to starter motor end frame.
4. Twist solenoid clockwise to remove flange key from keyway slot (located in starter motor), then remove solenoid assembly.

Replacement of Contacts

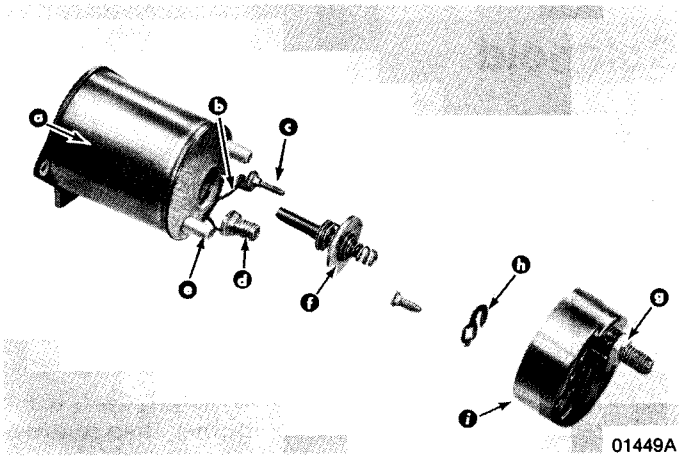
1. Remove nuts and washers from switch ("S") terminal and starter motor connector strap terminal.
2. Remove 2 solenoid end cover retaining screws and washers and remove end cover.
3. Remove nut and washer from battery terminal on end cover and remove battery terminal.

IMPORTANT: DO NOT cut starter motor connector strap terminal wire to remove terminal, or wire will be too short.

4. Remove motor connector strap terminal and solder new terminal in position.
5. Remove and install new battery terminal, washer and retaining nut.
6. Place new contact ring and push rod assembly.
7. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

Installation

1. Install solenoid return spring on plunger.
2. Position solenoid assembly to starter motor and turn solenoid to engage flange key in keyway slot.
3. Install 2 screws which hold solenoid assembly to end frame.
4. Secure starter motor connector strap terminal with screw and washer.
5. Install starter motor as outlined.



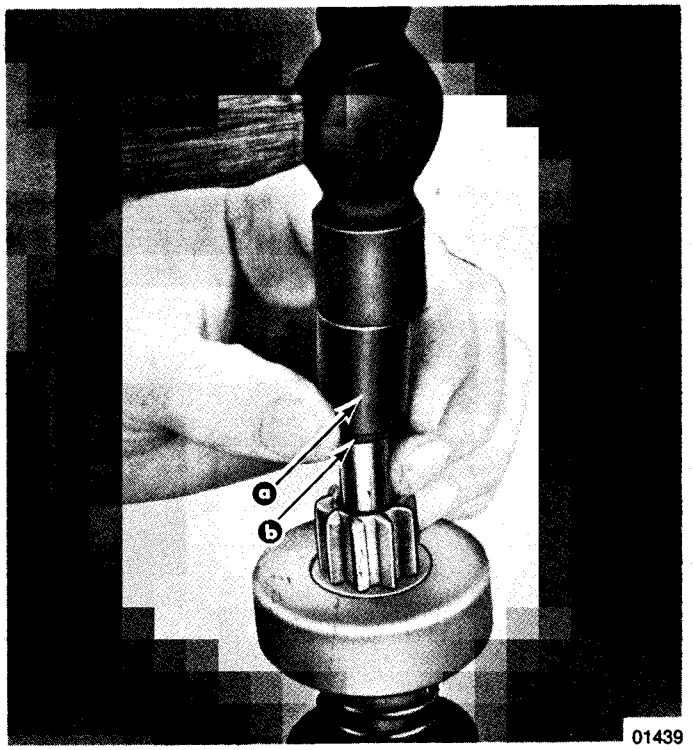
a - Solenoid Body
b - To Hold in Coil
c - Switch Terminal
d - Motor Connector Strap
e - To Pull in Coil
f - Contact Ring & Rod
g - Battery Terminal
h - Contact Finger
i - End Cover

Exploded View of Solenoid

Starter Motor Repair

Disassembly

1. Remove screw and washer which fasten motor field coil connector to solenoid terminal.
2. Remove thru bolts.
3. Remove commutator end frame, field frame assembly and armature assembly from drive housing.
4. Remove over-running clutch from armature shaft as follows:
   a. Slide thrust collar off of armature shaft.
   b. Slide standard 1/2" pipe coupling or other metal cylinder of correct size onto shaft. Tap end of coupling with hammer, driving retainer toward armature.
   c. Remove snap ring from groove.
   d. Slide retainer and clutch assembly from armature shaft.
5. Disassemble brushes and related parts from field frame as follows:
   a. Remove pin, which passes thru brush support and brush holders, and remove.
   b. Disconnect leads from brushes.



a - Cylinder
b - Retainer

Driving Off Retainer

Cleaning and Inspection

IMPORTANT: DO NOT use grease dissolving solvents for cleaning electrical components and bushings of starter motor. Such a solvent would damage insulation and remove lubricating qualities from bushings.

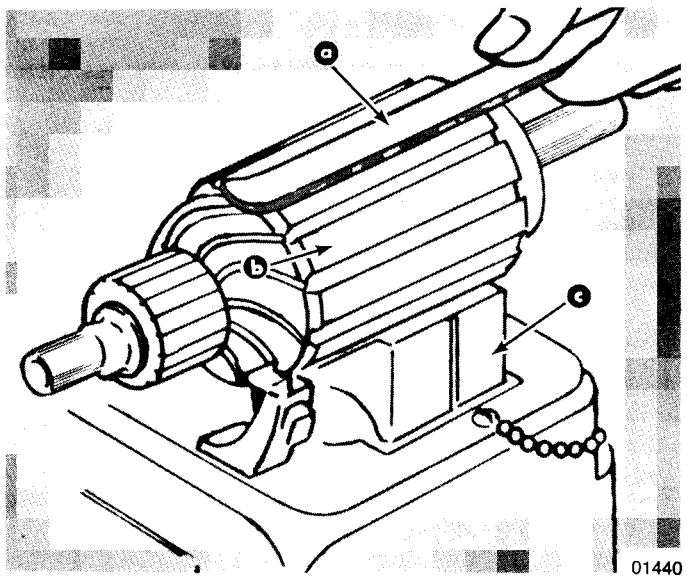
With starting motor completely disassembled, (except for removal of field coils), component parts should be cleaned and inspected. Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

1. Clean all starting motor parts but do not use dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.
2. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace, if necessary.
3. Check that brush holders are not damaged or bent and will hold brushes against commutator.
4. Check brushes. Replace if pitted or worn to one-half their original length [5/16" (8mm) or less].
5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly. Replace bushing, if worn, Apply SAE 20 oil to this bushing before reassembly. Avoid excessive lubrication.
6. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply SAE 20 oil to this bushing before reassembly. Avoid excessive lubrication.
7. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar usually is evidence of poor connection.

Component Tests

ARMATURE TEST for SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.

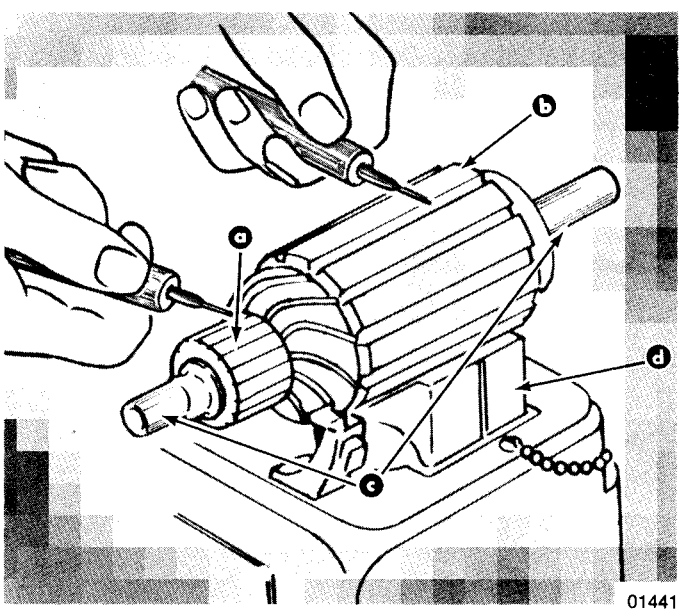


a - Hacksaw Blade
b - Armature Core
c - Growler

Armature Tests for Shorts

ARMATURE TEST for GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves to right, armature is grounded and must be replaced.



a - Commutator
b - Armature Core
c - Shaft
d - Growler

Armature Test for Ground Field Coil

LOOSE CONNECTIONS

If open soldered connection of armature to commutator leads is found during inspection, resolder with rosin flux.

IMPORTANT: Never use acid flux on electrical connections.

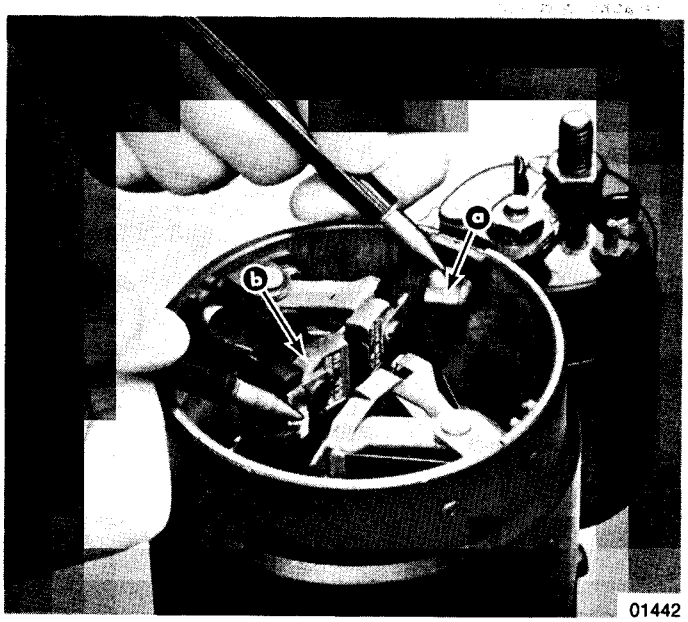
TURNING the COMMUTATOR

When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.
2. Recheck armature on growler for short circuits.

FIELD COIL TEST for OPEN CIRCUIT

1. With continuity meter, place one lead on each end of field coils (insulated brush and field connector bar).
2. If meter hand does not move to right, field coils are open and must be replaced.



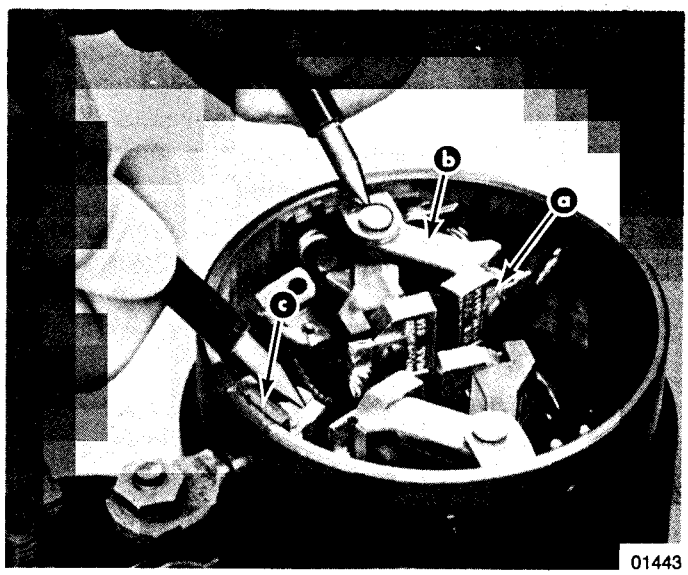
a - Field Connector Bar
b - Insulated Brush

Field Coil Test for Open Circuit

FIELD COIL TEST for GROUND

IMPORTANT: Be sure that positive brushes and leads do not contact field frame assembly during test, or false reading will result.

1. With continuity meter, place one lead on field connector bar and other lead on grounded brush.
2. If meter hand moves to right, field coils are grounded and must be replaced.



a - Grounded Brush
b - Brush Holder
c - Field Connector Bar

Field Coil Test for Ground

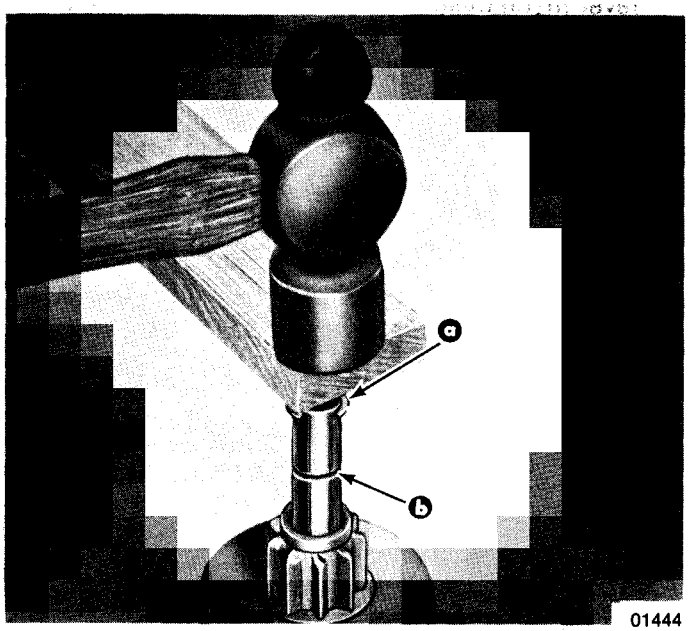
Reassembly

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter as follows:

1. Assemble brushes and related parts to field frame as follows:
   a. Assemble brushes to brush holders.
   b. Assemble insulated and grounded brush holders together with "V" spring. Position as a unit and install support pin. Push holders and spring to bottom of support and rotate spring to engage center of "V" spring in slot in support.
   c. Attach ground wire to grounded brush and field lead wire to insulated brush.
2. Assemble over-running clutch assembly to armature shaft as follows:
   a. Lubricate drive end of armature shaft with SAE 10 oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.

c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).

d. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.

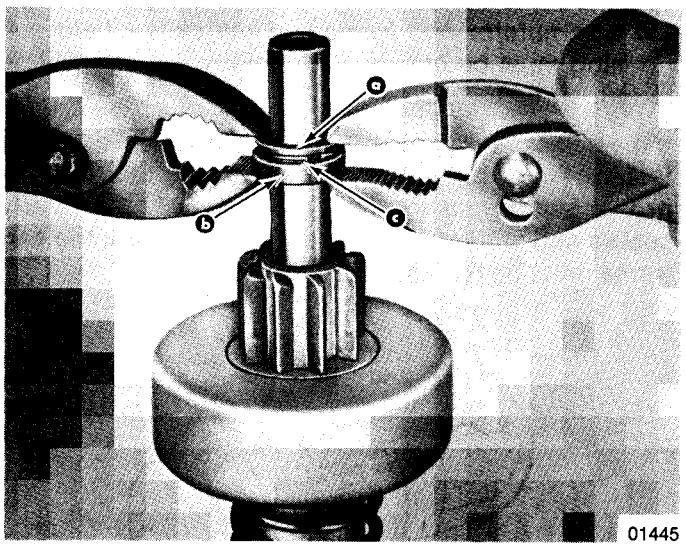


a - Snap Ring
b - Groove

Forcing Snap Ring Over Shaft

e. Assemble thrust collar on shaft with shoulder next to snap ring.

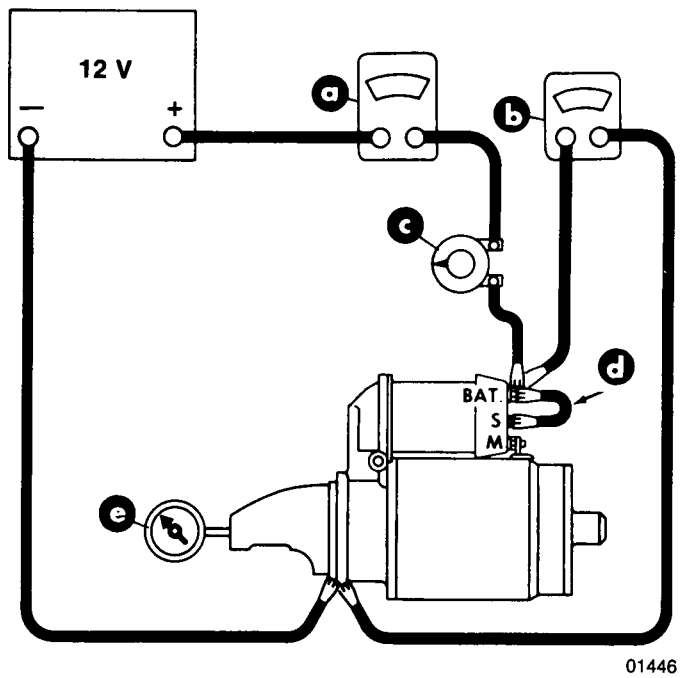
f. Position retainer and thrust collar next to snap ring. Then, using 2 pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.



a - Thrust Collar
b - Retainer
c - Snap Ring

Forcing Snap Ring into Retainer

3. Place 4 or 5 drops of SAE 10 oil in drive housing bushing. Slide armature and clutch assembly into place in drive housing while engaging shift lever with clutch.
4. Position field frame over armature and apply Liquid Neoprene between frame and solenoid case, observing caution to prevent damage to brushes.
5. Place 4 to 5 drops of SAE 10 oil in bushing in commutator end frame. Place leather brake washer on armature shaft and slide commutator end frame onto shaft.
6. Install solenoid as outlined.
7. After reassembly, a "no load" check of starting motor may be made if equipment is available. To check, connect starter motor in series with a fully-charged 12-volt battery, an ammeter capable of reading several hundred amperes and a variable resistance.
8. Also, connect a voltmeter, as illustrated, from motor terminal to motor frame. An RPM indicator is necessary to measure armature speed. Obtain specified voltage by varying resistance unit. Then read current draw and armature speed and compare these readings with specifications.



a - Ammeter
b - Voltmeter
c - Variable Resistor
d - Jumper Lead
e - RPM Indicator

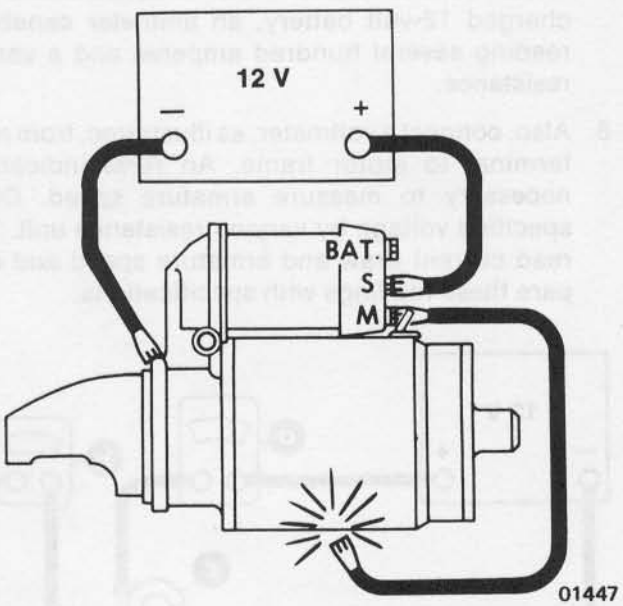
No Load Test Hookup

Clearances

PINION CLEARANCE

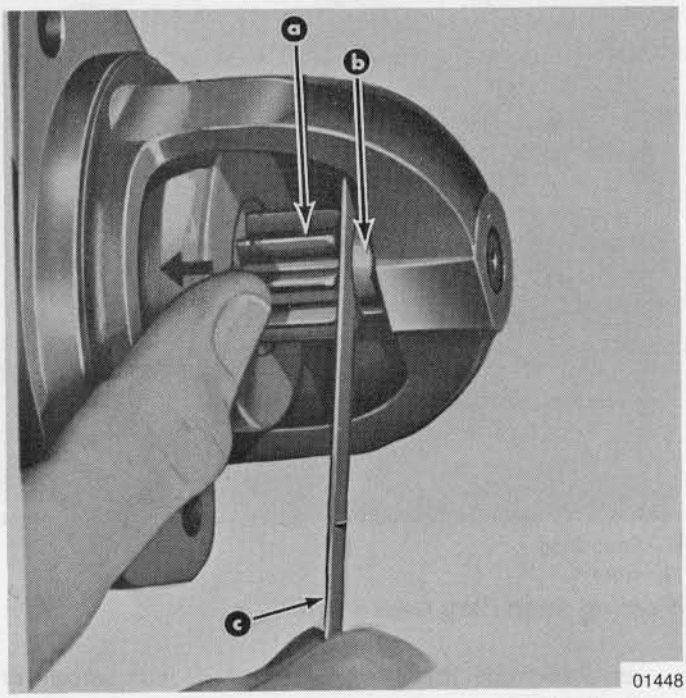
Pinion clearance must be checked after reassembly of motor to insure proper adjustment.

1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.
2. Connect 12-volt battery from solenoid switch terminal to solenoid frame.
3. Momentarily touch a jumper lead from solenoid motor terminal to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



Circuit for Checking Pinion Clearance

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer.
6. If clearance is not within specified limits, it may indicate excessive wear of solenoid linkage, shift lever yoke buttons, or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



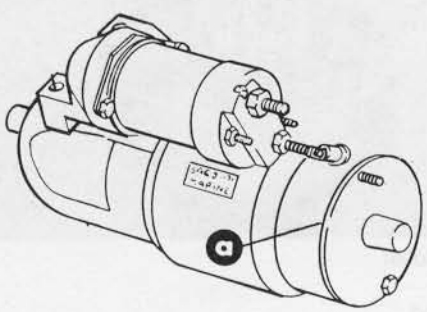
a - Pinion b - Retainer c - Feeler Gauge

Checking Pinion Clearance

COMMUTATOR END FRAME GAP

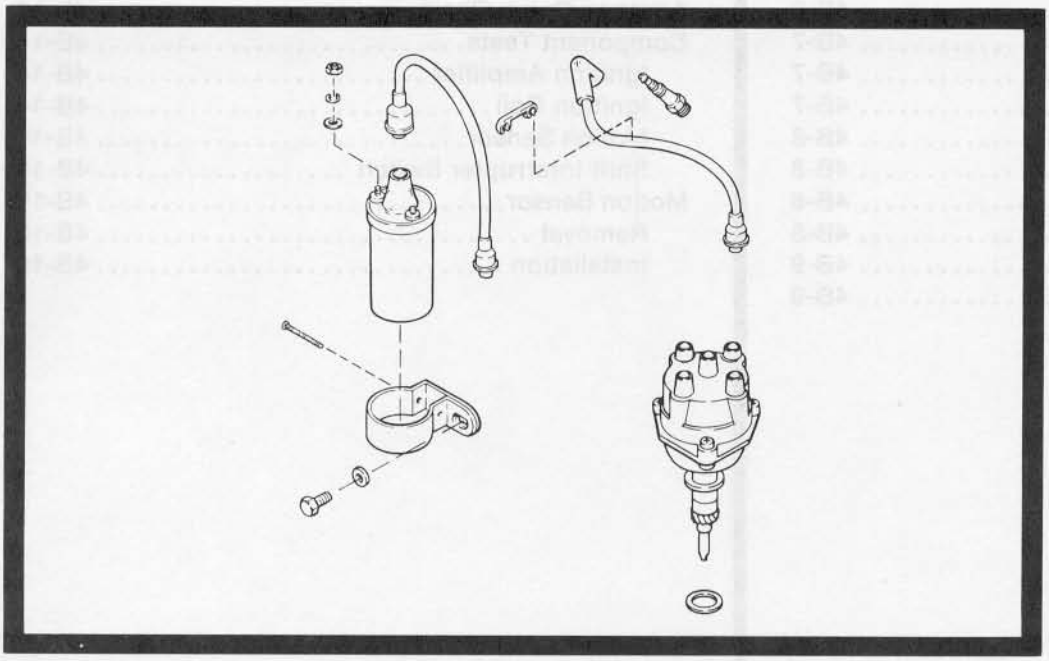
In order to maintain the ignition-proof characteristics designed into the starter for safety, the gap between the commutator end frame and the starter field coil housing must be checked. Generally, no gap will be found.

If the gap exceeds specifications when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the end frame must be replaced.



a - Check End Frame Gap Here

ELECTRICAL SYSTEM



4

B

IGNITION SYSTEM

mercruiser
STERN DRIVES & INBOARDS

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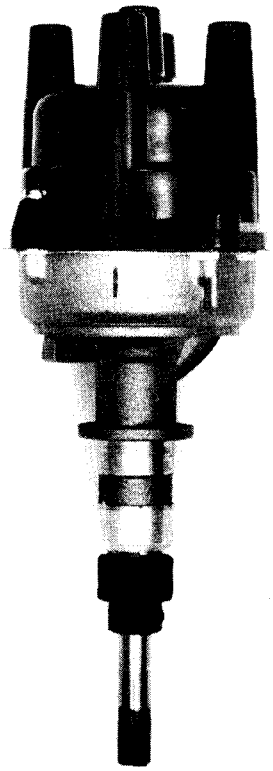
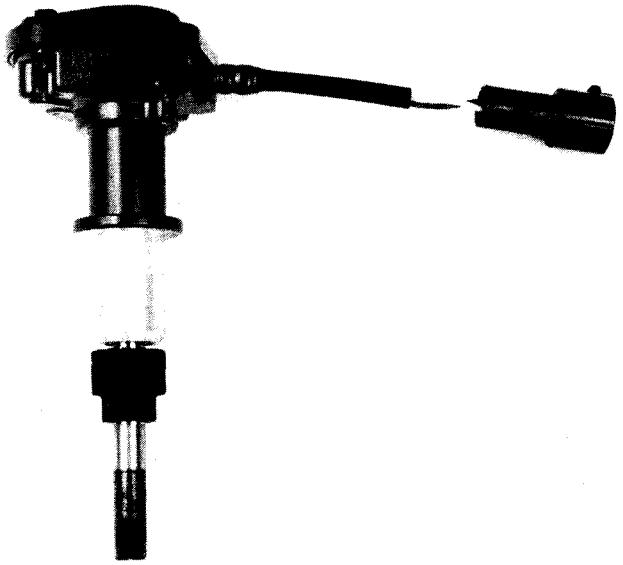
Identification



18383

Delco Distributor MCM 120/140/2.5 - 3.0 L

NOTE: The Delco distributor is superceded by a Prestolite distributor. Refer to service manual 13 for specifications and repair procedures.



26526

Digital Distributorless Ignition System (DDIS) MCM 3.0 L

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Delco Distributor System

Specifications

COIL

Coil Part No.	26433	32193
Max. Operating Amps*	.9	1.1
Primary Resistance*	.9 - 1.2 Ohms	1.3 - 1.5 Ohms
Secondary Resistance*	7,500 - 10,500 Ohms	9,400 - 11,700 Ohms
Secondary Continuity*	53-63	67-77
Resistor Wire	1.8 - 2 Ohms	

NOTE: *Use Magneto Analyzer

UNIT OF MEASUREMENT
in. (mm)

DISTRIBUTOR

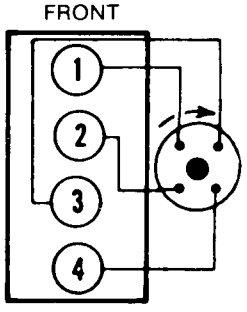
Model	120/2.5 L	140/3.0 L
Condenser*	.18 - .25 MFD.	
Point Dwell	28° - 34°	
Point Gap	.022 (.5)	
Point Spring Tension	19-23 oz. (540-650g)	
Timing	8° BTDC	6° BTDC

NOTE: *Use Magneto Analyzer

SPARK PLUGS

Model	120/140/2.5-3.0 L
Gap	.035 (.9)
Type	AC MR43T Champion RV8C NGK BR6FS

FIRING ORDER - GM 4 Cyl. In-line



FIRING ORDER
1-3-4-2

Torque Specifications

Fastener Location	Lb. Ft. (N.m)
Distributor Clamp 5/16-18	15 (20)
Distributor Clamp 3/8-16	20 (27)
Spark Plugs 14mm	15 (20)

Tools/Lubricants/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-59339	Dwell Meter
91-76032	Magneto Analyzer
91-52024A1	Remote Starter Switch
91-99379	Timing Light
91-99750A1	Multi-Meter/DVA Tester

TOOLS OBTAINED LOCALLY
Point Spring Tension Gauge

SEALANTS	
92-25711-2	Quicksilver Liquid Neoprene

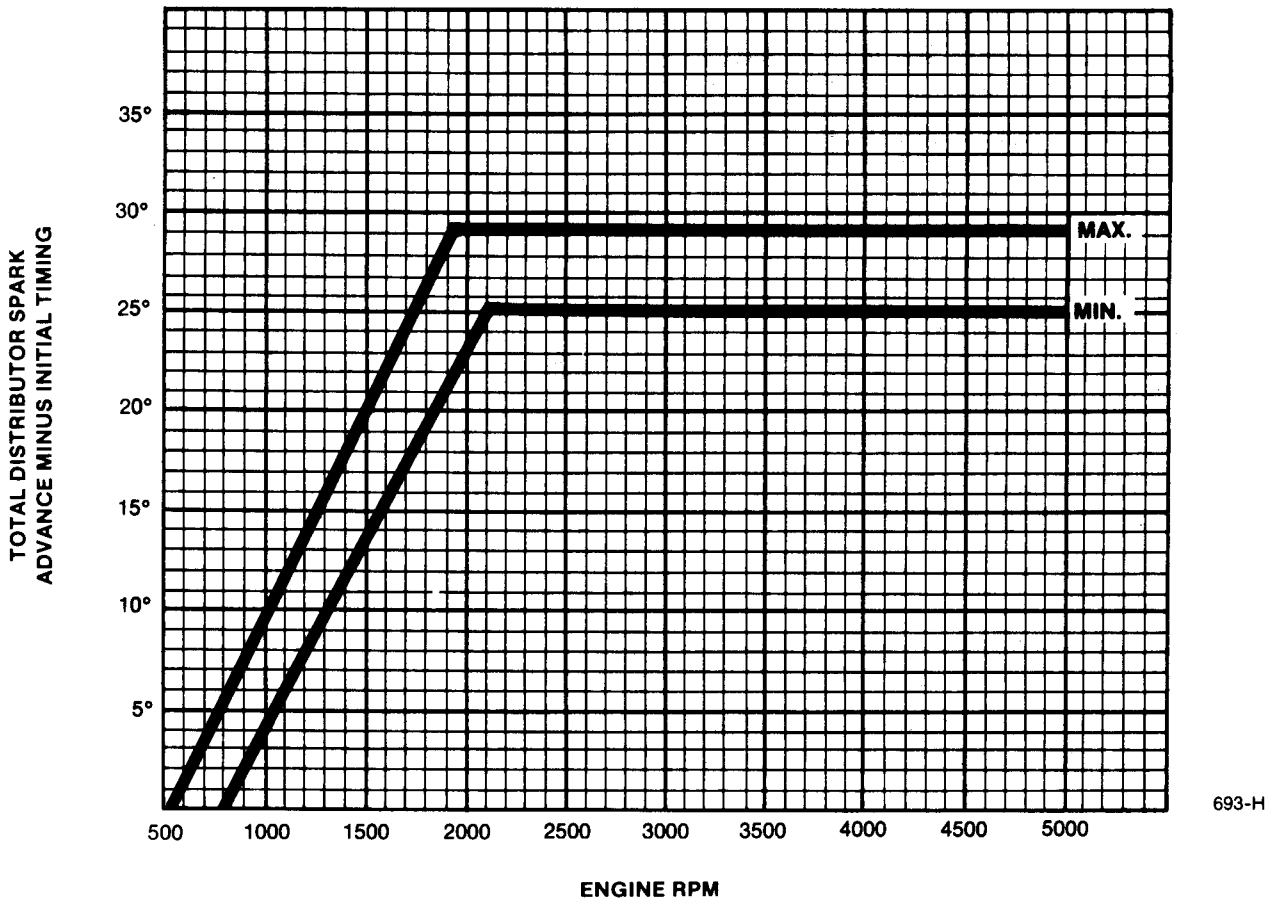
LUBRICANTS OBTAINED LOCALLY
Distributor Cam Lubricant

Distributor Advance Curve

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

EXAMPLE: Advance curve chart reads 29° spark advance at 2000 RPM. Add 6° BTDC initial timing for a 140 and total spark advance at 2000 RPM is 35°.

MCM 120/140/2.5-3.0 Litre



Repair

Precautions

⚠WARNING
When performing the following procedure, be sure to observe the following.

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet, and clothing clear of engine moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (-) ground.**
- **Do not disconnect battery cables while engine is running.**

Distributor Cap and Rotor

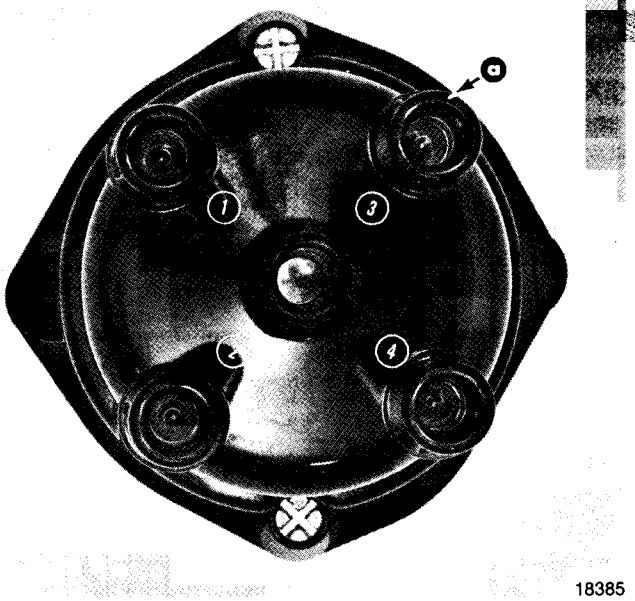
1. Loosen distributor cap retaining screws.
2. Remove distributor cap.

IMPORTANT: If high tension leads are removed from cap, replace in correct firing order.

3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contacts for excessive burning or corrosion. Check center contact for deterioration.

IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

5. Check cap for cracks or carbon tracks using Magneto Analyzer.
6. Remove rotor.
7. Check for burned or corroded center contact.
8. Check rotor for cracks and carbon tracks using Magneto Analyzer.
9. Install rotor on shaft. Make sure to line up rotor with keyway on distributor shaft. Be sure rotor is completely seated on distributor shaft.
10. Place cap on distributor. Make sure notch on cap lines up with notch in distributor and cap is firmly seated.
11. Tighten retaining screws securely.
12. Install spark plug wires (if removed) as shown.



a - Alignment Notch Location

4 Cylinder Distributor Cap Wiring
L.H. and R.H. Rotation

Contact Points

1. Examine contact points for dirt, wear, pitting and misalignment. Dirty points should be cleaned. Normal point condition is an overall grey color on contact surface.
2. Check for point resistance. A voltage drop of less than .125 volts across points should exist. Make this check with a sensitive volt meter or point resistance meter.

ABNORMAL POINT WEAR

1. Points, which have been operated for a period of time, have a rough surface, but this may not mean that points are worn out.
2. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition is corrected, new points will provide no better service than old points.

CLEANING OF POINTS

1. Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

IMPORTANT: Never use emery cloth to clean contact points.

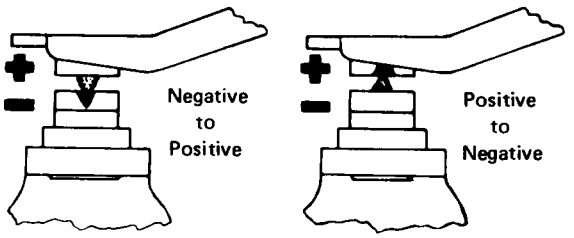
2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

BURNING OF POINTS

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser and improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly.
4. If contact point opening is too small (cam angle too large), points will be closed too long. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points.
5. High series resistance in condenser circuit will prevent normal condenser action, so contact points will burn rapidly. This resistance may be caused by a loose condenser mounting or lead connection, or by poor connections inside condenser.

PITTING OF POINTS

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other.



Material Transfer

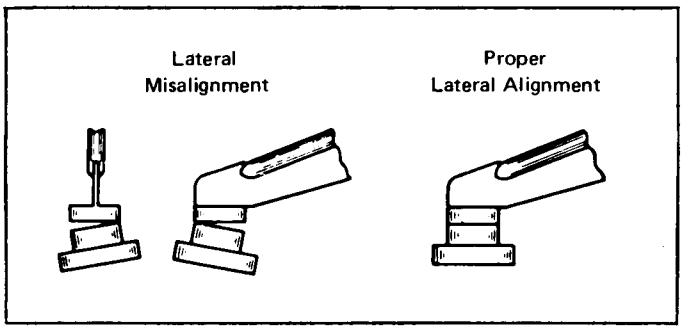
2. If points are pitted, condenser should be checked for proper capacity.

Replacement

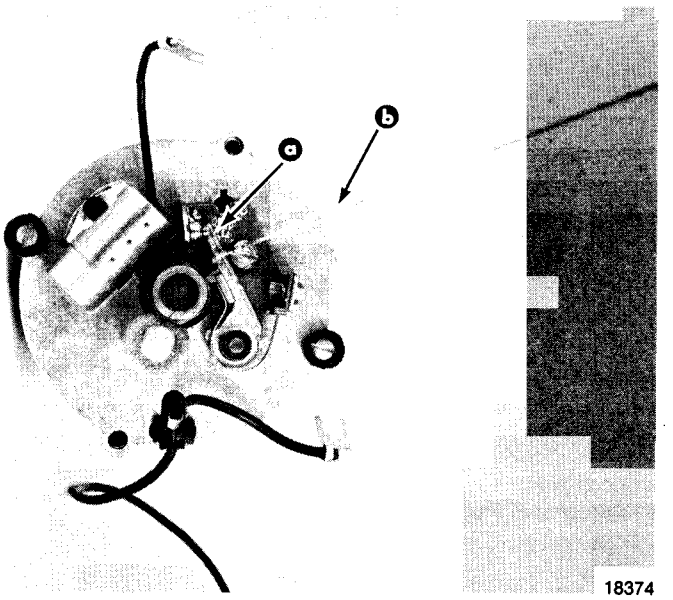
1. Remove primary and condenser lead wires from contact point terminal.
2. Remove contact set attaching screw and lift contact point set from breaker plate.
3. Clean oil smudge and dirt from breaker plate.

IMPORTANT: Carefully wipe protective film from point set prior to installation.

4. Place a small amount of Distributor Cam Lubricant on distributor cam.
5. Place new contact point assembly in position on breaker plate and install attaching screw.
6. Check points for proper alignment. If points do not align properly, replace with another set of points.



7. Connect primary and condenser lead wires to terminal on contact point set.
8. Check point spring tension.



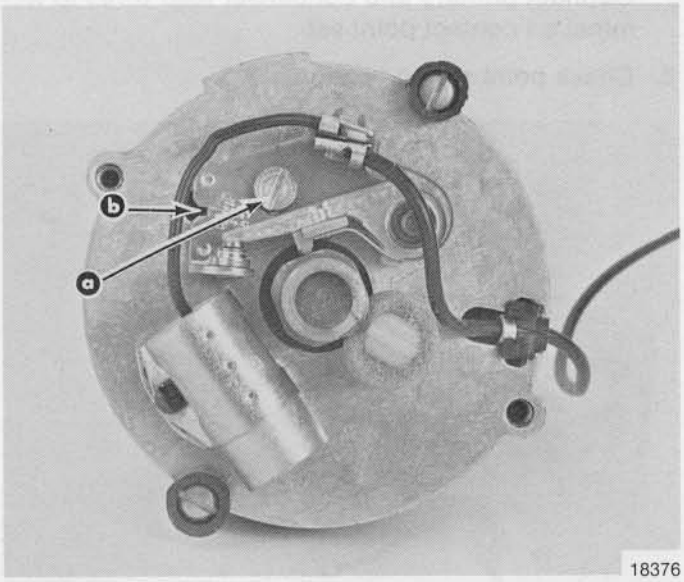
a - Movable Contact
b - Spring Tension Gauge

Contact point pressure must fall within specified limits. Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Contact point pressure should be checked with a spring gauge. Scale should be hooded to breaker lever and pull exerted at 90° to breaker lever. Reading should be taken just as points separate. Pressure can be adjusted by bending breaker lever spring. If pressure is excessive, it can be decreased by pinching spring carefully. To increase pressure, remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.

IMPORTANT: Point gap or (dwell) can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter. Points, however, also can be adjusted, as well as checked, with a dwell meter: After points have been set, dwell should be checked with engine running.

POINT ADJUSTMENT WITH FEELER GAUGES

1. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
2. Insert correct feeler gauge between breaker points.
3. Loosen lock screw and adjust points to specifications

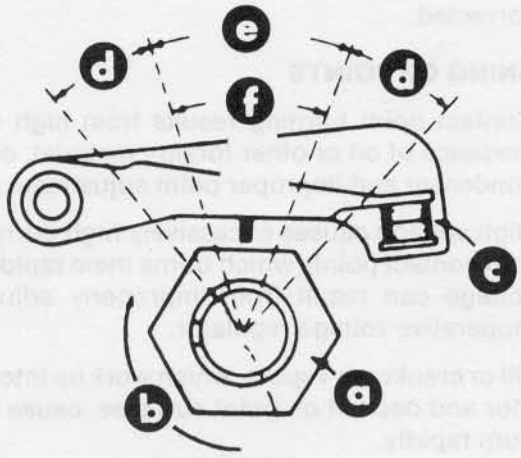


a - Lock Screw
b - Adjustment Slot

DWELL ADJUSTMENT

1. Remove distributor cap and rotor.
2. Connect positive (+) dwell meter lead to negative (-) side of coil. Connect negative (-) meter lead to ground.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver to obtain reading on dwell meter, as specified in "Specifications", and tighten lock screw. (Dwell reading will be unsteady using this method.)

IMPORTANT: Cam angle increases as point opening is decreased and vice versa.



a - Cam
b - Direction of Rotation
c - Breaker Points
d - Points Open
e - Points Close
f - Cam Angle or Dwell

Cam Angle

5. Install rotor and distributor cap and recheck dwell with engine running.

IMPORTANT: Dwell should be checked between idle and 1750 RPM. Any dwell reading variations of more than 3° between idle and 1750 RPM would indicate wear in the distributor. Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some dwell meters.

Condenser

1. Use Magneto Analyzer for test.
2. Test condenser for the following:
   a. Condenser capacity test.
   b. Condenser leakage and short test.
   c. Condenser series resistance test.
3. Replace condenser if test results are not within specifications.

Coil

1. Use Magneto Analyzer for test.
2. Check coil for the following:
   a. Coil power test.
   b. Coil surface insulation test.
   c. Coil continuity test.
   d. Primary resistance test.
   e. Secondary resistance.
3. Replace coil if test results are not within specifications.

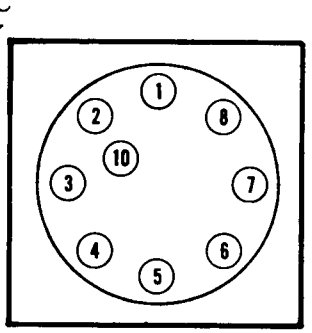
Ignition Resistance Wire

ENGINE WITH ELECTRIC CHOKE

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wires. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".

ENGINE WITHOUT ELECTRIC CHOKE

1. Disconnect wire from positive (+) side of coil.
2. Unplug instrumentation harness from engine harness.
3. Connect one ohmmeter lead to wire removed from coil. Connect other ohmmeter lead to No. 5 pin hole in engine harness. Replace resistor wire if reading is not within specifications.
4. Reconnect wire to coil. Plug instrumentation harness onto engine harness and tighten retaining clamp securely.
5. For instructions on replacing resistor wire refer to "Section 3, Part E".



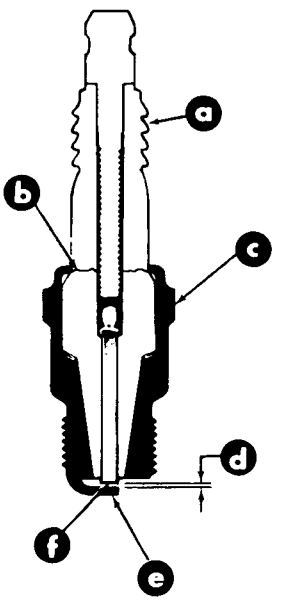
Engine Harness Connector

Spark Plugs

1. Inpsect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications" for spark plug numbers.

IMPORTANT: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. Refer to "Specifications" for proper spark plug gap.



a - Porcelain Insulator
b - Insulator Cracks Often Occur at this Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File Flat When Adjusting Gap - Do Not Bend)

Spark Plug Detail

4. Clean spark plug seating area. DO NOT use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas-tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with nontapered (with gasket) spark plugs.

High Tension Leads

1. Inspect high tension leads for damage.
2. Check high tension leads for continuity.
3. Replace any leads that are cracked, cut, or have damaged spark plug boots.
4. Replace any leads that do not show continuity from end to end.
5. Reinstall high tension leads in proper order.

IMPORTANT: Proper positioning in high tension lead supports is important to prevent cross firing.

Distributor Repair

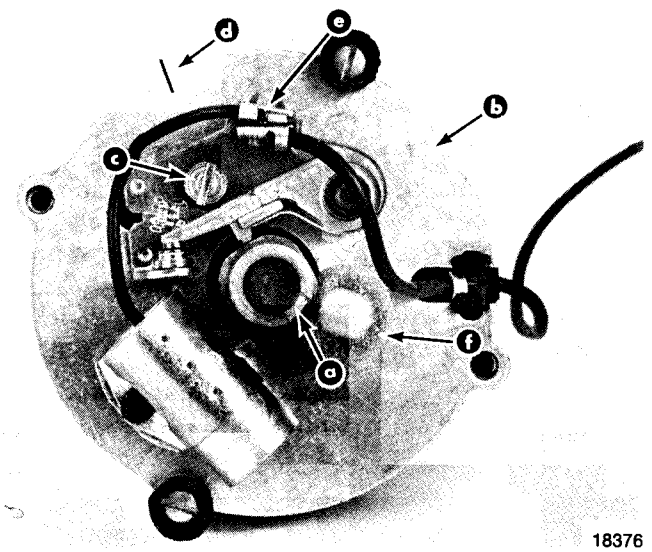
Removal

1. Disconnect distributor primary lead from coil terminal.
2. Remove distributor cap and rotor.

IMPORTANT: If necessary to remove leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.

3. Scratch a realignment mark on distributor in line with rotor notch (located on distributor shaft).
4. Mark distributor housing in relation to engine block for ease in installation.
5. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation.

IMPORTANT: Avoid rotating engine with distributor removed, as ignition timing will be upset.



18376

a - Rotor Alignment Notch
b - Breaker Plate
c - Breaker Point Attaching Screw
d - Alignment Mark
e - Quick Disconnect Terminal
f - Lubrication Wick

Breaker Plate and Attaching Parts

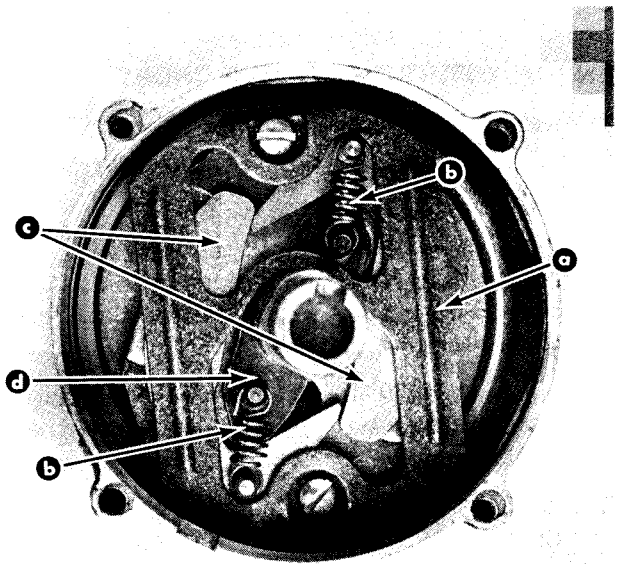
Disassembly

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Remove condenser and breaker points from breaker plate. Test condenser and check breaker points.
2. Remove breaker plate from distributor housing. Excessive oil on breaker plate assembly would indicate a bad oil seal in distributor housing.

IMPORTANT: Main shaft bushings and oil seal in housing are not serviced separately. Housing, bushings and oil seal are serviced as complete assembly.

3. Remove roll pin retaining driven gear to main shaft and slide gear from shaft.
4. Check for side play between main shaft and bushings in distributor housing. Maximum side play allowed is .002" (.05mm).
5. Remove main shaft from housing and inspect for worn cam lobes. Check shaft for being bent by placing in v-blocks and checking run out with a dial indicator. Maximum run out allowed is .002" (.05mm).
6. Remove weight cover, check weights and weight stop for wear. Check weights for free movement on pins.



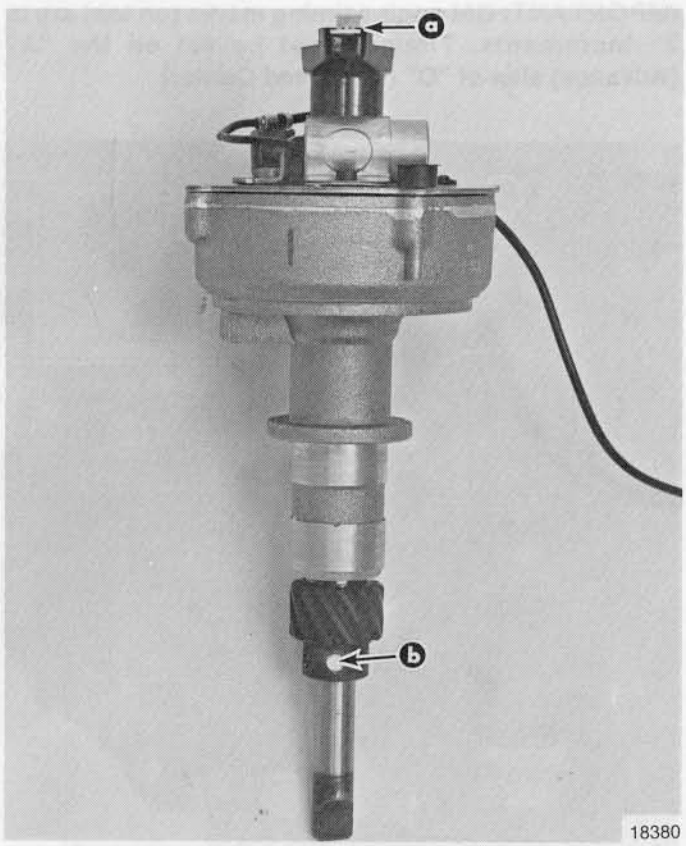
18610

a - Weight Cover
b - Weight Springs
c - Weights
d - Weight Stop

Advance Weights and Components

Reassembly

1. Install weights and springs on pivot pins.
2. Install weight cover.
3. Lubricate main shaft with engine oil and install in distributor housing.
4. Install thrust washers (if applicable) and install driven gear on main shaft.
5. Line up mark on driven gear with rotor notch on main shaft.
6. Install roll pin through gear and main shaft.
7. Install breaker plate on distributor housing.
8. Install condenser and breaker points on breaker plate.
9. Install distributor as outlined in "Distributor Installation", (see Index).



a - Rotor Contact
b - Gear Alignment Mark

Gear Installation

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counter-clockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Refer to "Specification", for firing order.

5. Set point gap and dwell.
6. Install rotor and cap.
7. Time ignition as outlined under "Ignition Timing".

Engine Disturbed

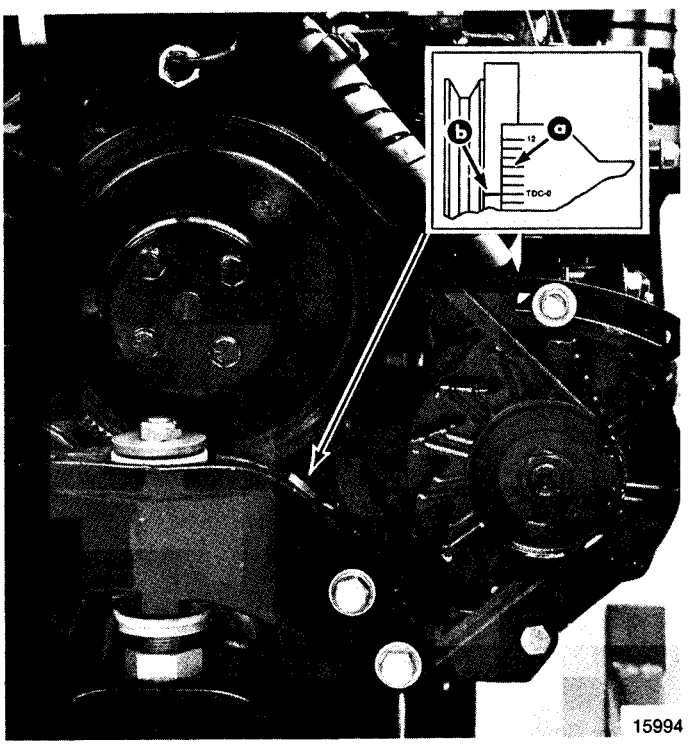
1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley or. . .
   b. Remove rocker cover and crank engine until No.1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more toward left and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Refer to Specifications for firing order.
8. Set point gap and dwell.
9. Time ignition as outlined under "Ignition Timing".

Ignition Timing

IMPORTANT: Dwell must be set to specification before adjusting timing.

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing marks as shown.
5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications". Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. Timing must be set on the "A" (Advance) side of "O" (Top Dead Center)



a - Timing Mark
b - Degree Marks

Timing Marks on GM 4 Cylinder

Digital Distributorless Ignition System (DDIS)

Specifications

COIL

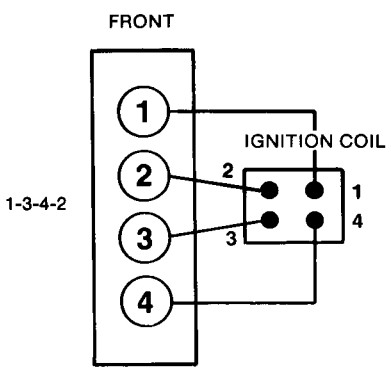
Primary Resistance	1.9 - 2.5 Ω *
Secondary Resistance	11.3 - 15.5 K Ω *

* At Room Temperature 68° F (20° C)

IGNITION TIMING

Timing	8° BTDC at 700 RPM

FIRING ORDER



Torque Specifications

Fastener Location	Lb. Ft. (N·m)
Motion Sensor Clamp 3/8-16	20 (27)
Ignition Amplifier	65 lb. in. (7.3)
Ignition Coils	20 lb. in. (2.2)
Spark Plugs	15 (20)

TOOLS	
Remote Starter Switch	91-52024A1
Timing Light	91-99379
Volt/Ohm Meter	91-99750

SEALANTS/LUBRICANTS	
Liquid Neoprene	92-25711-2
Quicksilver 2-4-C Marine Lube	92-825407A2

SPARK PLUGS
3.0L
AC-MR43T NGK-BR6FS Champion-RV8C
Spark Plug Gap

Description

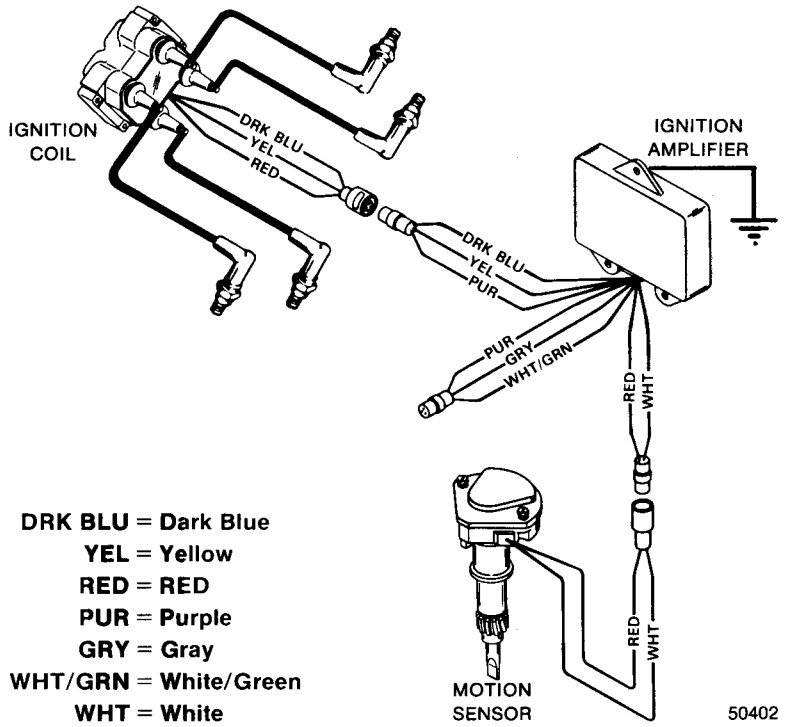
The Digital Distributorless Ignitions System (DDIS) replaces the conventional point style ignition system.

A motion sensor replaces the conventional distributor and senses crankshaft position.

The ignition amplifier controls coil output, spark advance, and limits engine speed to approximately 5000 RPM.

The ignition coil is actually two coils in one with four high voltage towers. The coils are fired on both compression stroke and exhaust stroke.

MCM 3.0 LITRE
DDIS SYSTEM COMPONENTS



DRK BLU = **Dark Blue**
YEL = **Yellow**
RED = **RED**
PUR = **Purple**
GRY = **Gray**
WHT/GRN = **White/Green**
WHT = **White**

Spark Advance Control

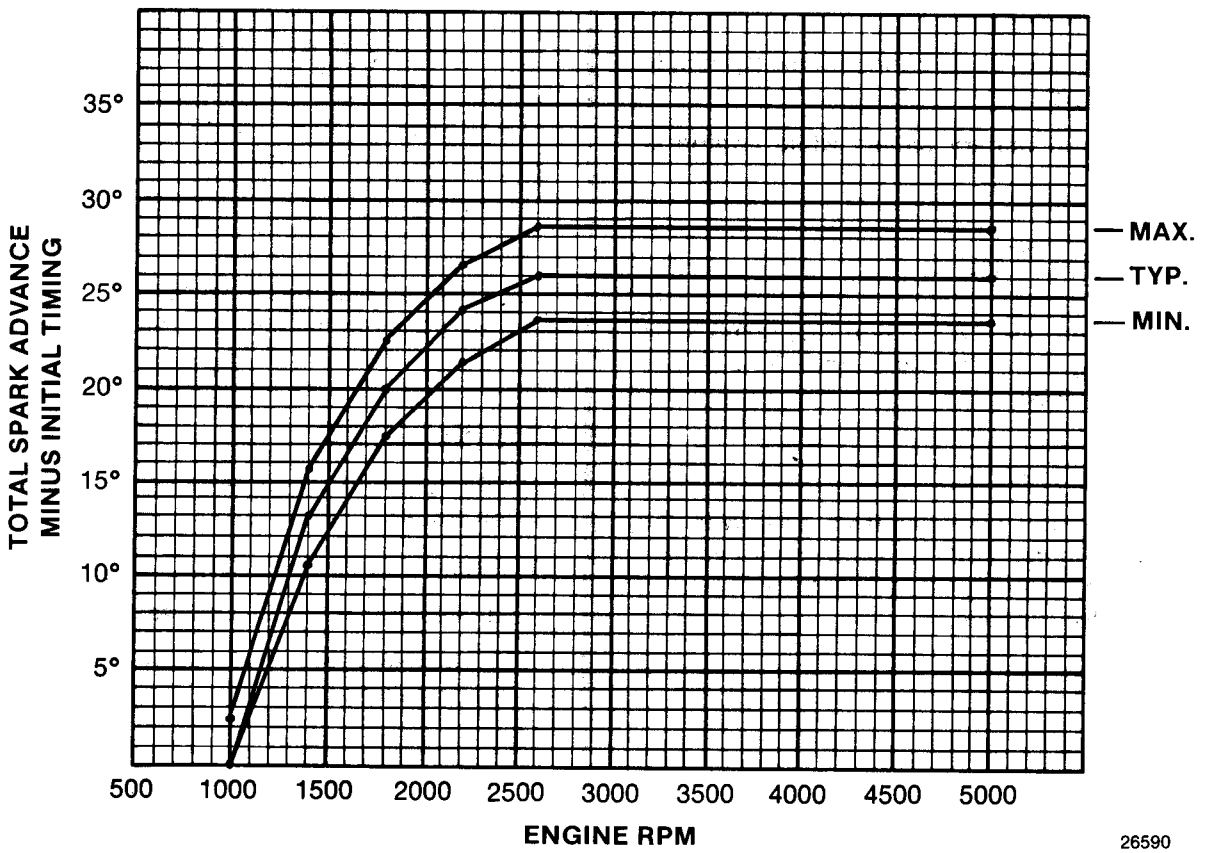
The ignition amplifier controls spark advance above 1000 RPM. There is no adjustment. Initial timing must be set below 1000 RPM.

NOTE: Many timing lights are inaccurate at high engine speeds, therefore timing should not be adjusted above 1000 RPM.

Advance Curve Chart (reference only)

IMPORTANT: Advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

EXAMPLE: Advance curve chart shows 24° spark advance at 2200 RPM. Add 8° BTDC initial timing for a total spark advance of 32° at 2200 RPM.



⚠WARNING

When performing the following procedures, be sure to observe the following:

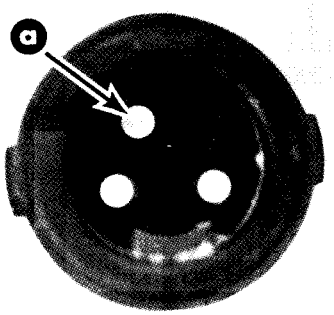
- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet, and clothing clear of moving engine parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (-) ground.**
- **Do not disconnect battery cables while engine is running.**

Component Tests

IMPORTANT: Check spark plugs and spark plug wires before the DDIS system. Use multi-meter 91-99750 to test DDIS components.

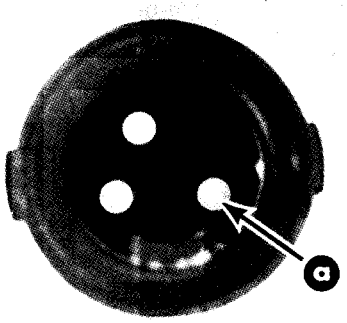
Ignition Amplifier

1. Disconnect ignition amplifier from coil. With the ignition switch in the "RUN" position, check voltage at terminal (a) from ignition amplifier. Reading should be battery voltage.



26522

2. Disconnect engine harness from ignition amplifier. With ignition switch in the "RUN" position, check voltage at terminal (a) from engine harness. Reading should be battery voltage.



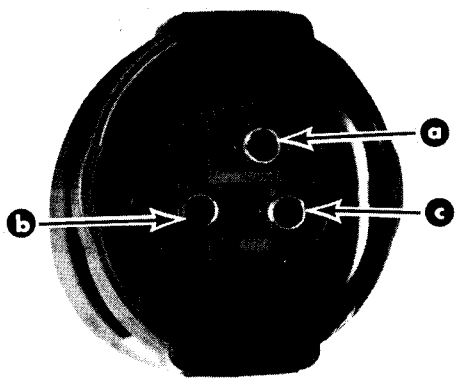
26522

3. If voltage readings in steps one and two differ more than approximately 1/2 volt, ignition amplifier is defective.

Ignition Coil

NOTE: Ignition switch must be in the "OFF" position when testing ignition coil.

1. Primary coil resistance:
   a. Disconnect coil from ignition amplifier.
   b. Measure resistance between coil connector terminals as shown.

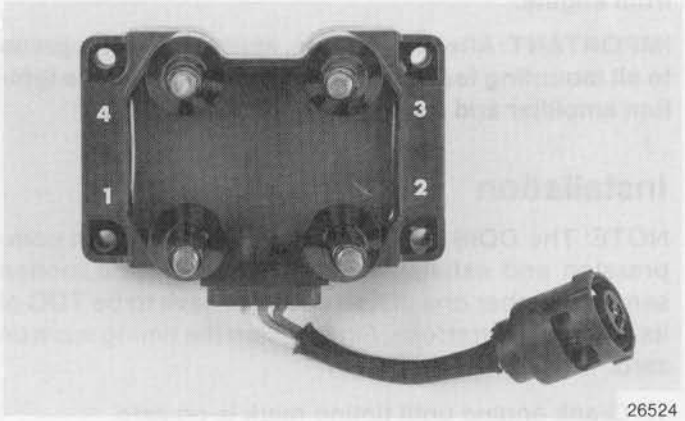


26520

TERMINALS	RESISTANCE RANGE
a to b	1.9 - 2.5 Ω *
a to c	

* At Room Temperature 68° F (20° C)

2. Secondary coil resistance:
   a. Disconnect spark plug wires from coil high voltage towers.
   b. Measure resistance between towers as shown.

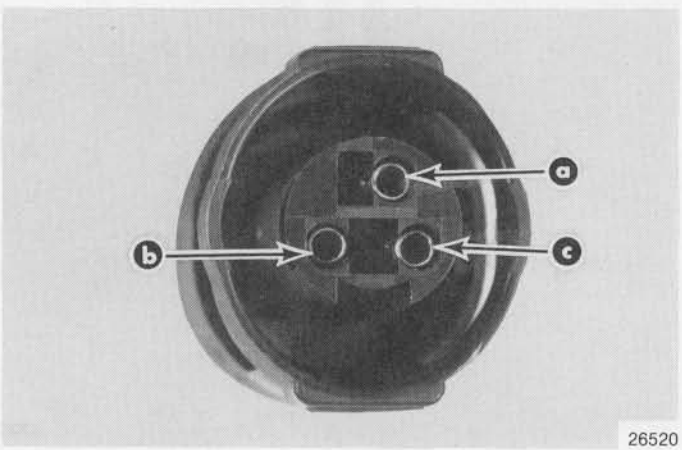


26524

HIGH VOLTAGE TOWERS	RESISTANCE RANGE
1 to 4	11.3 - 15.5 K Ω *
2 to 3	

* At Room Temperature 68° F (20° C)

3. Coil insulation resistance:
   a. Measure resistance between coil connector terminal (a) and engine ground. Minimum resistance - 10 megohms.



26520

   b. Measure resistance between each high voltage tower and engine ground. Minimum resistance - 10 megohms.

Motion Sensor

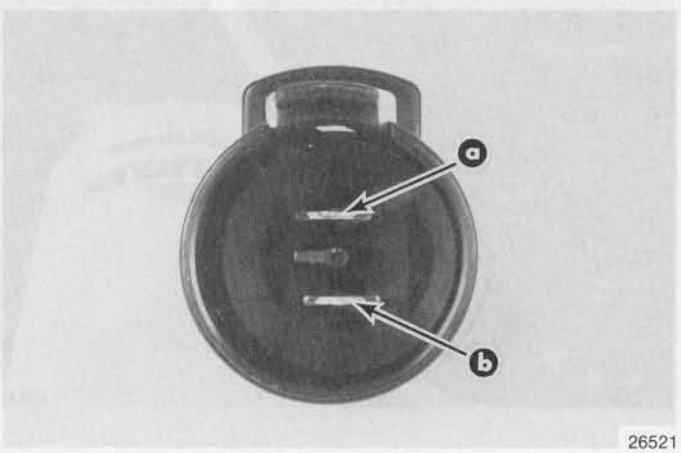
NOTE: Motion sensor is factory set and not adjustable.

IMPORTANT: Do not remove cover (a) unless it is damaged. There are no serviceable parts inside the motion sensor. Replace entire unit if defective.

26549

1. With ignition switch in the "OFF" position, disconnect motion sensor from ignition amplifier. Measure resistance between sensor terminals (a) and (b). Resistance range - 140 to 180 ohms. If resistance is not within specifications, replace motion sensor.

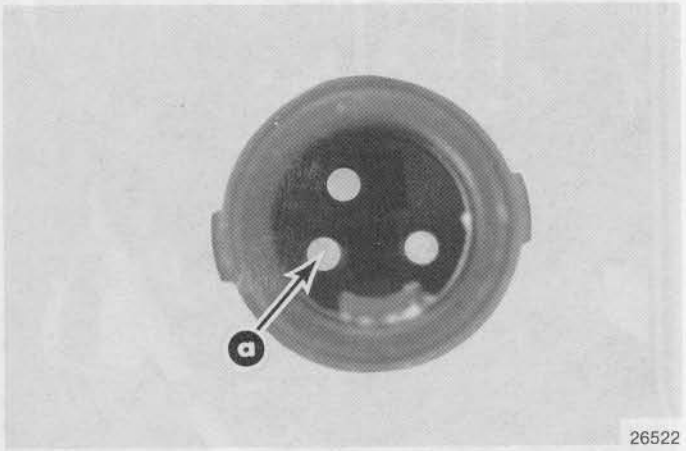
IMPORTANT: Motion sensor must be at room temperature, 68° F (20° C), when testing.



26521

Shift Interrupter Switch

1. Disconnect ignition amplifier from engine harness. Check for continuity between harness connector (a) and engine ground. Switch is normally open. When shifting into forward or reverse, switch will close momentarily.



26522

Motion Sensor

Removal

1. Disconnect wires (a).

26549

2. Crank engine until timing mark is on zero.
3. Remove motion sensor.

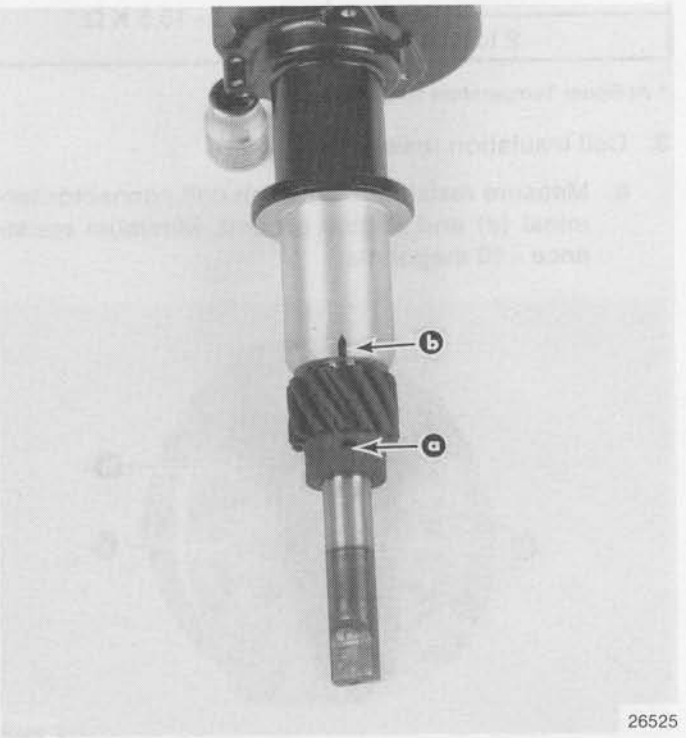
IMPORTANT: To simplify motion sensor reinstallation, do not turn crankshaft while motion sensor is removed from engine.

IMPORTANT: After installation, apply Liquid Neoprene to all mounting fasteners and ground wires of the ignition amplifier and ignition coil.

Installation

NOTE: The DDIS signals the coil to fire on both compression and exhaust strokes. To install the motion sensor, number one piston does not have to be TDC of its compression stroke. Simply align the timing mark on zero.

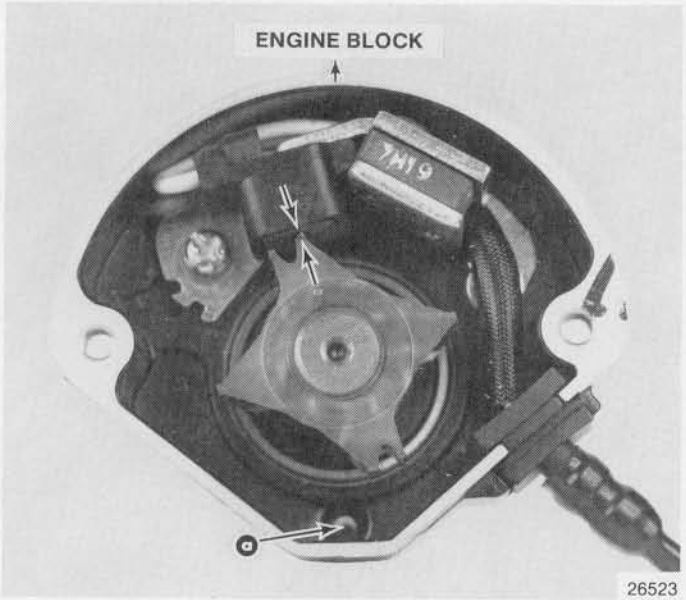
1. Crank engine until timing mark is on zero.
2. Align hole (a) [not roll pin hole] in gear with notch (b) on motion sensor housing. Install new gasket. Apply Quicksilver 2-4-C Marine Lube to gear.



26525

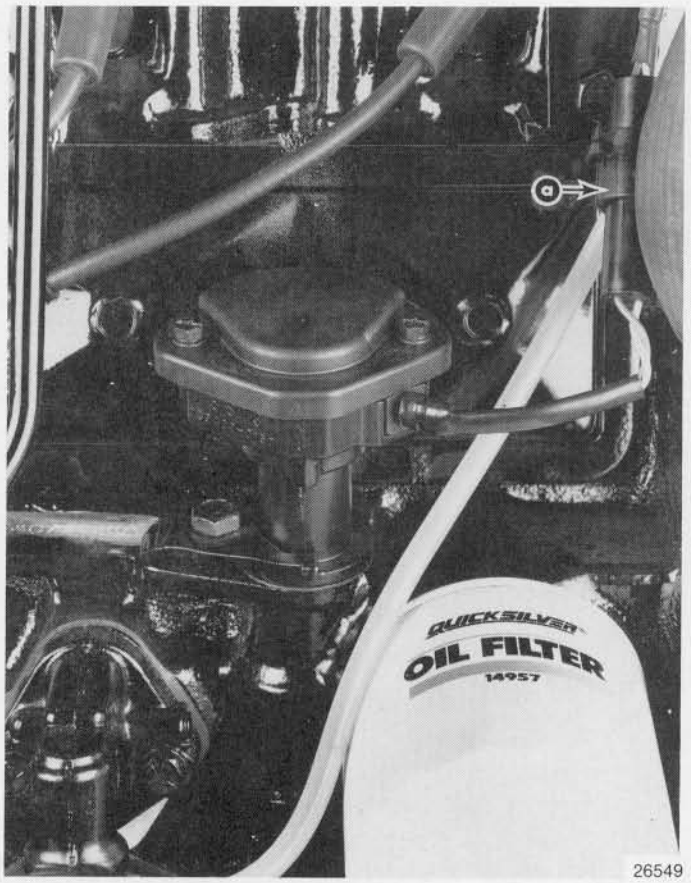
NOTE: When installing motion sensor it may be necessary to turn oil pump drive shaft for alignment with motion sensor drive shaft.

3. Remove motion sensor cover. Install motion sensor so drain hole (a) is opposite engine block and sensor is aligned as shown.



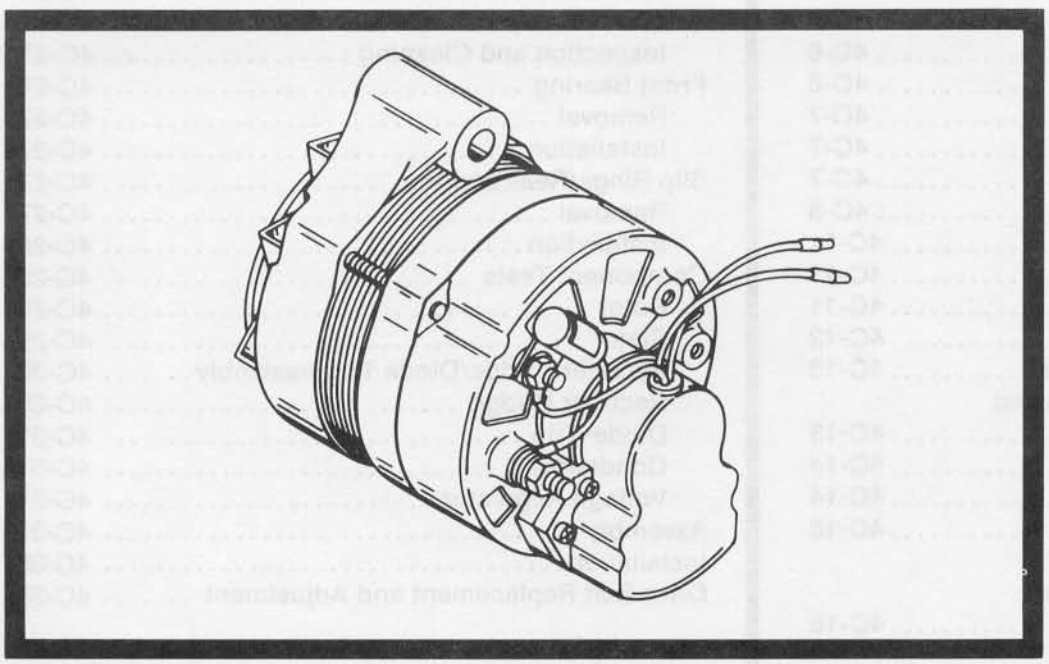
26523

4. Reinstall cover. Tighten screws securely.
5. Connect wires (a). Adjust timing to specifications. Tighten clamp to 20 lb. ft. (27 N·m).



26549

ELECTRICAL SYSTEM



4

C

CHARGING SYSTEM

mercruiser
STERN DRIVES & INBOARDS

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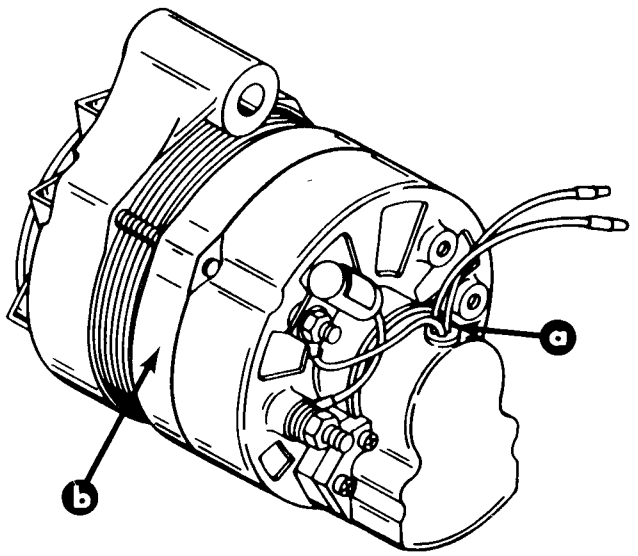
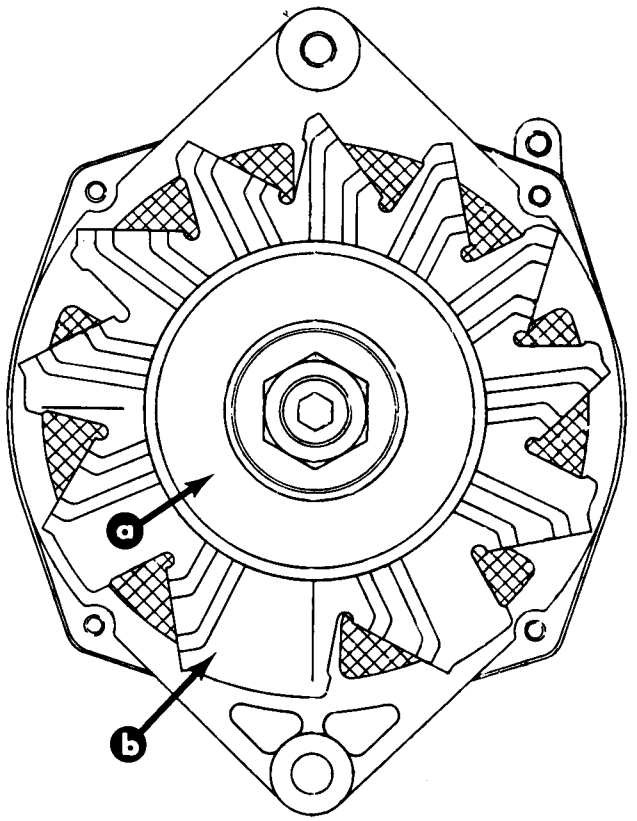
Identification



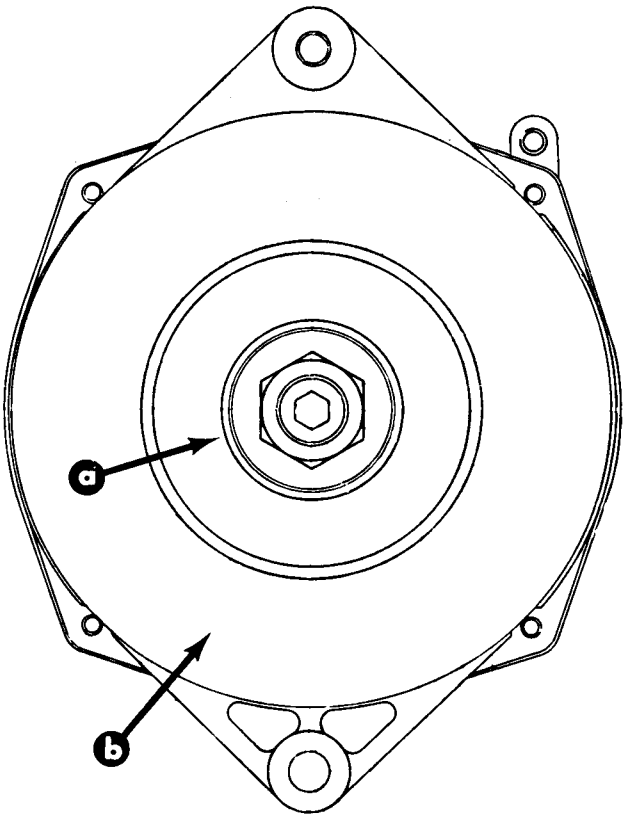
a - 2 Wires Going to Engine Harness Coming Out the Top of Regulator
b - Mando Number

Mando



a - Pulley
b - Exposed Cooling Fins - Do Not Use This Alternator On MIE R.H. (Opposite) Rotation Engiens

Uni-Rotational Alternator



a - Pulley
b - Covered Cooling Fins - This Alternator Can Be Used on All Engines

Bi-Rotational Alternator

Replacement Parts Warning

⚠WARNING

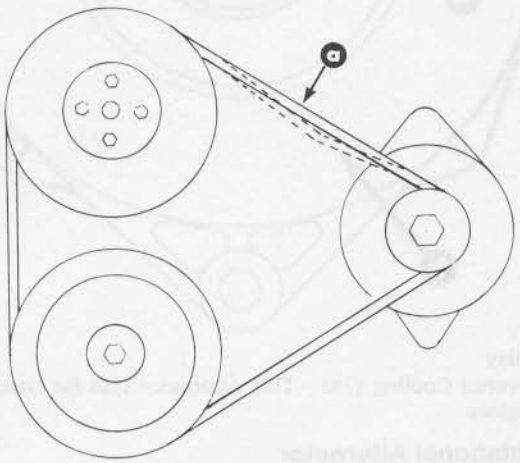
Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Drive Belt Tension Adjustment

Alternator

1. Install drive belt on pulleys and adjust tension as follows.
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely re-tighten alternator brace attaching bolts and alternator mounting bolts.



a - Belt Should Depress 1/2" (13mm)

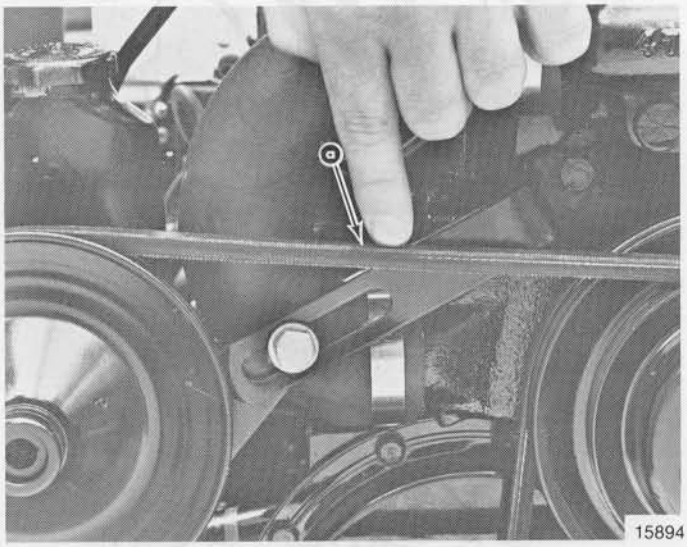
Alternator Drive Belt Tension

2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.

Power Steering Pump

IMPORTANT: DO NOT pry on pump with pry bar or screwdriver.

1. Install drive belt on pulleys and adjust tension as follows.
   a. Pivot pump away from engine, as required, until correct tension is obtained as shown.
   b. After obtaining correct tension, securely re-tighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for 5 minutes.



15894

a - Belt Should Depress 1/4" (6mm)

Mando Alternator

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace To Alternator		192 (28)
Alternator Brace To Block	30 (41)	
Alternator To Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Brush Retaining Screws	Securely	
Pulley Nut	50 (68)	
Rectifier Heat Sinks	Securely	
Regulator Retaining Screws	Securely	
Thru Bolts	Securely	

Tools/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-31229A5	Bearing Removal and Installation Kit
91-76032	Magneto Analyzer
91-37241	Universal Puller Plate
91-99750A1	Multi-Meter/DVA Tester

TOOLS PURCHASED LOCALLY
Ammeter (0-50 Amps)

SEALANTS	
92-25711-2	Quicksilver Liquid Neoprene

Specifications

Mercury Number (Mando Number)	Amp Output (Max.)	Rotation
98555 (AR150AA)	55	Uni-Directional

Description

The alternator system, used on engines with Mando Alternators, consists of the alternator, battery, the ignition switch and the wiring which connects these components. Refer to "Section 3 Part F" for wiring diagrams.

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

Precautions

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the "Troubleshooting Test".
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and the positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connections.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under "Drive Belt Tension Adjustment".
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with the "Troubleshooting" in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe "Precautions", immediately preceding, to prevent damage to alternator system.

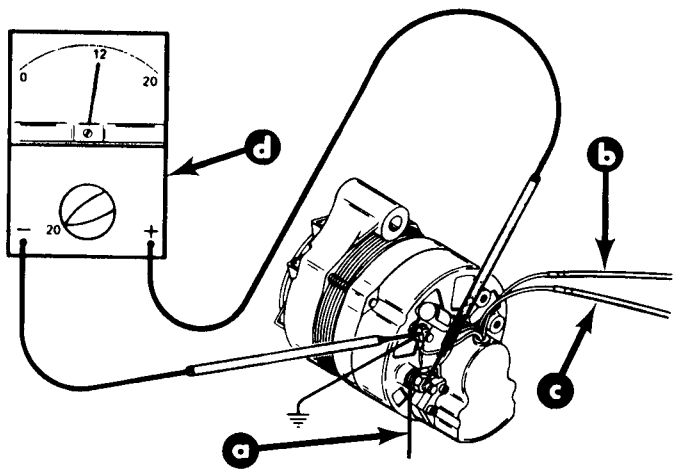
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in "Storage Battery" in "Section 4 Part A". Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under "Drive Belt Replacement and Tension Adjustment".

Circuitry Test

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

OUTPUT CIRCUIT

1. Connect positive voltmeter lead to alternator output terminal and negative lead to a ground terminal on alternator.
2. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximately battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.

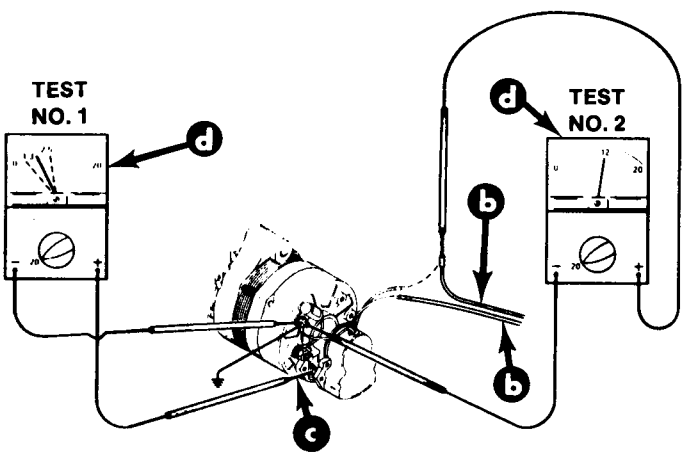


a - Output Wire - Orange
b - Excitation Wire - Purple
c - Sensing Wire - Red/Purple
d - Volt Meter (0-20 Volts)

Alternator Output Circuit Test

EXCITATION CIRCUIT

1. Remove 4 screws which secure the regulator to the alternator.
2. Connect positive (+) voltmeter lead to regulator terminal (green wire) on alternator and negative (-) lead to a ground terminal on alternator. (Test No. 1)
3. Turn ignition switch to "On" position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
4. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug purple lead from regulator. Connect positive voltmeter lead to purple lead and negative voltmeter lead to ground. (Test No. 2) If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.
5. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under "Alternator Repair", following.
6. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than 1/4" (6mm) long. If brushes and slip rings are in good condition, disassemble alternator and test rotor, as outlined under "Alternator Repair".

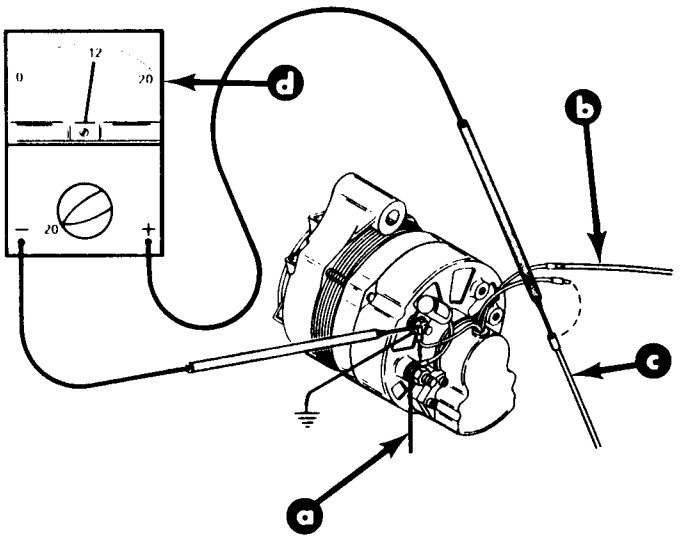


a - Excitation Wire - Purple
b - Sensing Wire - Red/Purple
c - Green Wire
d - Voltmeter (0-20 Volts)

Alternator Excitation Circuit Test

SENSING CIRCUIT

1. Unplug red/purple lead from voltage regulator.
2. Connect positive voltmeter lead to red/purple lead and negative voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connections or damaged wiring.



a - Output Wire - Orange
b - Excitation Wire - Purple
c - Sensing Wire - Red/Purple
d - Volt Meter (0-20 Volts)

Regulator Sensing Circuit Test

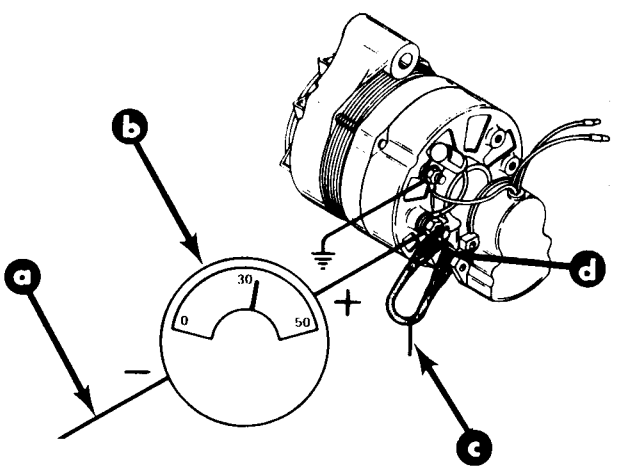
Current Output Test

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (-) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil hi-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diode trio is faulty. Disassemble alternator and replace diode trio, as explained under "Alternator Repair", following.
8. If reading is still low with jumper wire connected, perform "Voltage Regulator Test", following, to determine if fault is in regulator or alternator.



a - Output Wire - Orange
b - Ammeter (0-50 Amps)
c - Jumper Lead
d - Regulator Terminal (Green Wire)

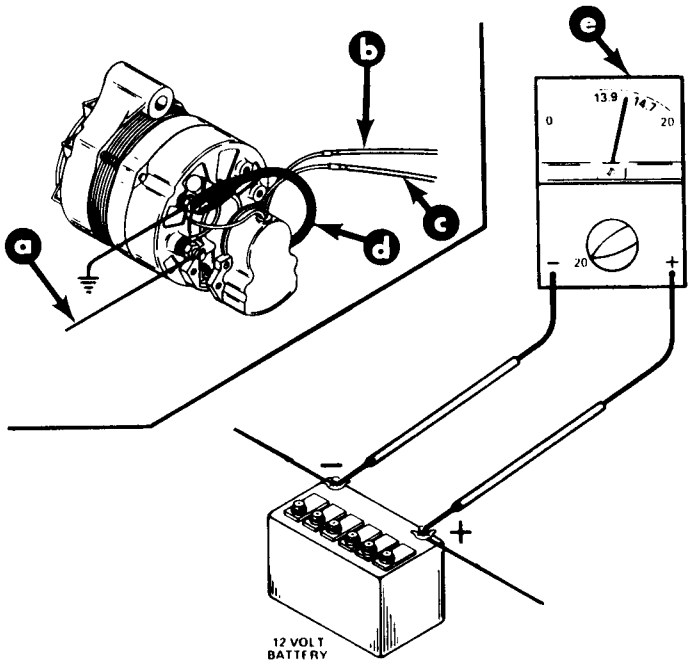
Alternator Current Output Test

Voltage Output Test

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC volmeter.

IMPORTANT: Battery MUST BE fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

1. Connect positive (+) voltmeter lead to positive battery terminal and negative (-) voltmeter lead to negative terminal.
2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checked out good in "Alternator System Circuitry Test"), voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.



a - Output Wire - Orange
b - Excitation Wire - Purple
c - Sensing Wire - Red/Purple
d - Jumper Lead (To Tan Wire and Ground)
e - Voltmeter (0-20 Volts)

Voltage Regulator Test

⚠WARNING
Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the next steps) to prevent the possibility of an explosion and/or fire, should a spark occur.

⚠CAUTION
DO NOT allow jumper wire to contact alternator end frame (in next step), as diode trio and regulator may be damaged.

4. If reading is low, stop engine and remove 4 regulator attaching screws. Pull regulator away from alternator end frame to gain access to field terminal. DO NOT disconnect regulator terminals. Connect a jumper lead from the ground stud to the brush terminal that has a tan wire attached. Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. DO NOT allow voltage to exceed 16 volts.
5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator is faulty and must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components, as outlined under "Alternator Repair", following.

Alternator Repair

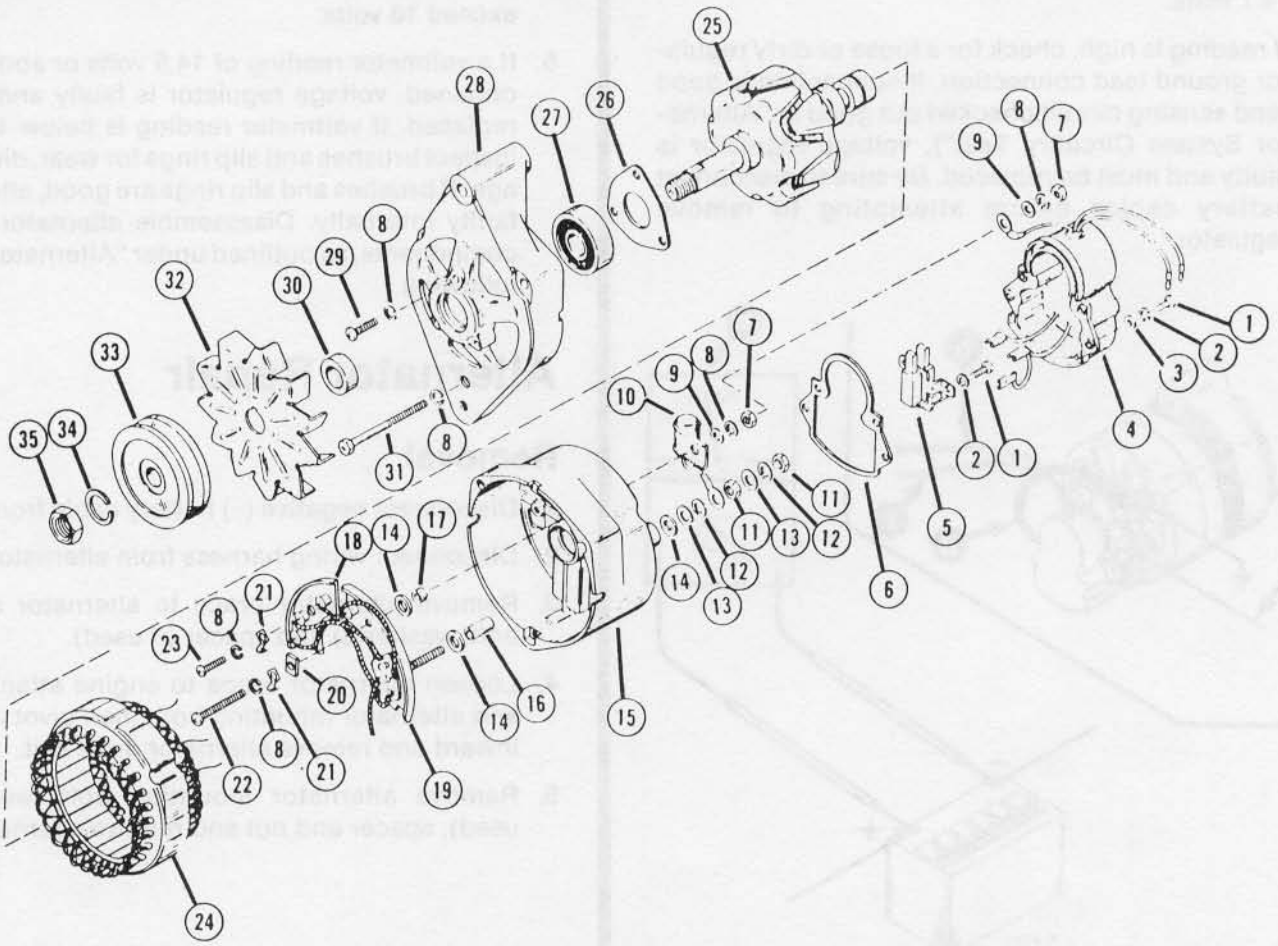
Removal

1. Disconnect negative (-) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace to alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace to engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut and remove alternator.

Disassembly

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise so that rear end frame is facing you.
2. Disconnect regulator leads from terminals on rear end frame. Remove 4 regulator attaching screws, then pull regulator away from rear end frame and disconnect regulator field leads. Remove regulator rubber seal.
3. Remove 2 brush set attaching screws and remove brush set.



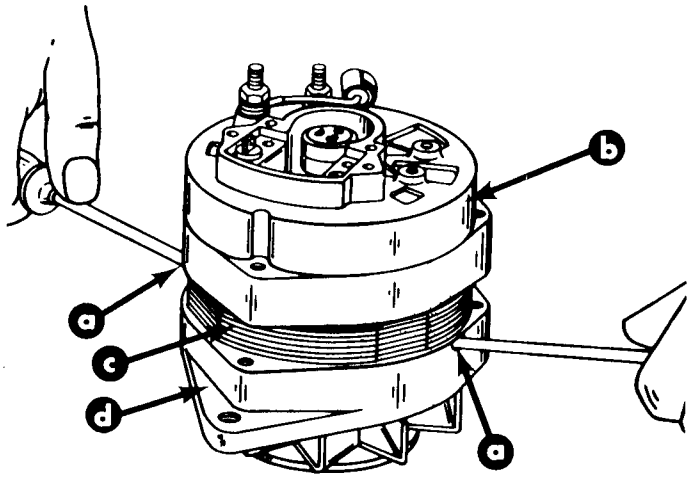
1 - Screw (6)
2 - Lockwasher (6)
3 - Flatwasher (4)
4 - Regulator
5 - Brush Set
6 - Rubber Seal
7 - Nut
8 - Lockwasher (6)
9 - Flatwasher (2)
10 - Condenser
11 - Nut
12 - Lockwasher (2)
13 - Flatwasher (2)
14 - Insulating Washer (3)
15 - End Frame
16 - Insulating Sleeve - Long
17 - Insulating Sleeve - Short
18 - Negative (-) Rectifier
19 - Positive (+) Rectifier
20 - Insulator - Rectangular
21 - Clip (2)
22 - Screw (1)
23 - Screw (2)
24 - Stator
25 - Rotor
26 - Retaining Plate
27 - Front Bearing
28 - End Frame
29 - Screw (3)
30 - Spacer
31 - Screw (3)
32 - Fan
33 - Pulley
34 - Lockwasher
35 - Nut

Mando Alternator Parts View

4. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
5. Remove 3 screws which secure end frames and stator together.

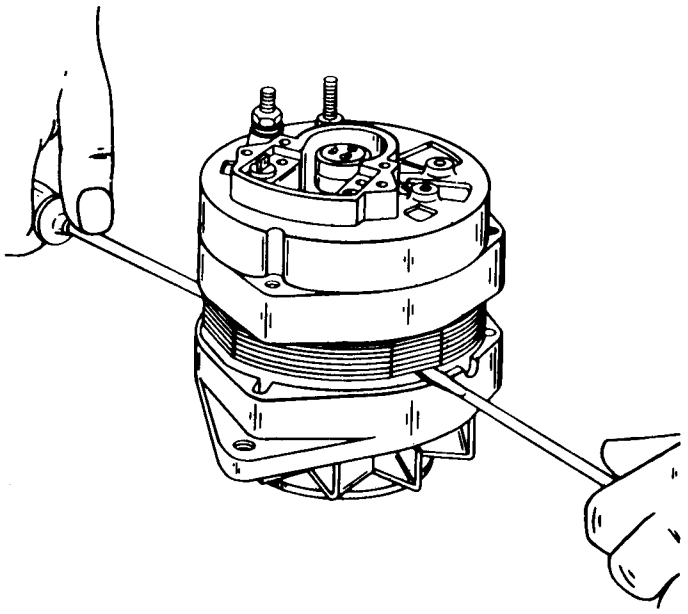
IMPORTANT: DO NOT insert screwdriver blades more than 1/16" (1.6mm) into openings (in next step), as stator windings may be damaged.

6. Separate rear end frame and stator assembly from front end frame and rotor assembly using 2 thin blade screwdrivers (positioned at 180° apart from one another) at the location shown. Use the two slots, shown to initially separate units.



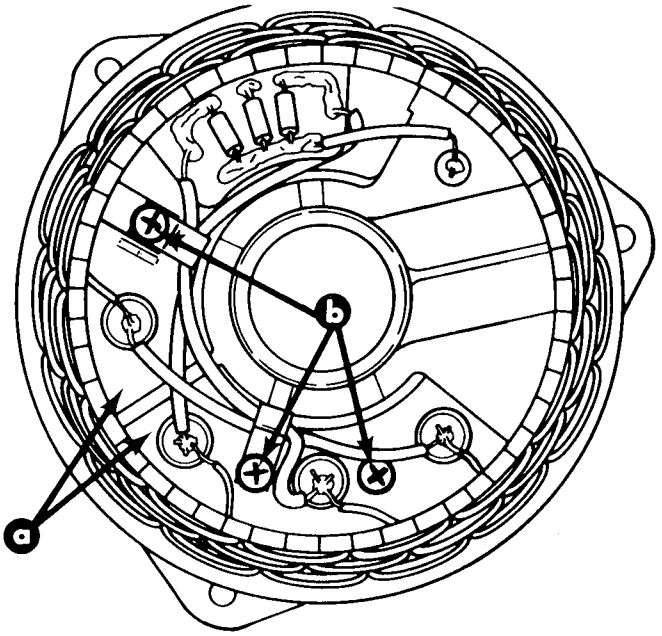
a - DO NOT Insert Screwdriver Blades More than 1/16" into Slots
b - Rear End Frame
c - Stator
d - Front End Frame

Separating Rear End Frame and Stator Assembly from Front End Frame and Rotor Assembly



Separating Rear End Frame and Stator Assembly from Front End Frame and Rotor Assembly

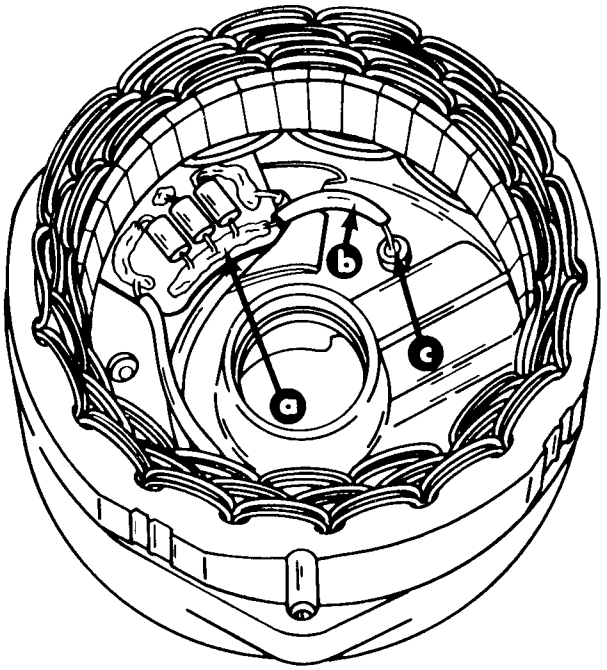
7. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.
8. Turn end frame over (stator upward) and remove the three phillips head screws which secure rectifiers to end frame.



a - Rectifiers
b - Phillip Head Screws

Removing Rectifiers

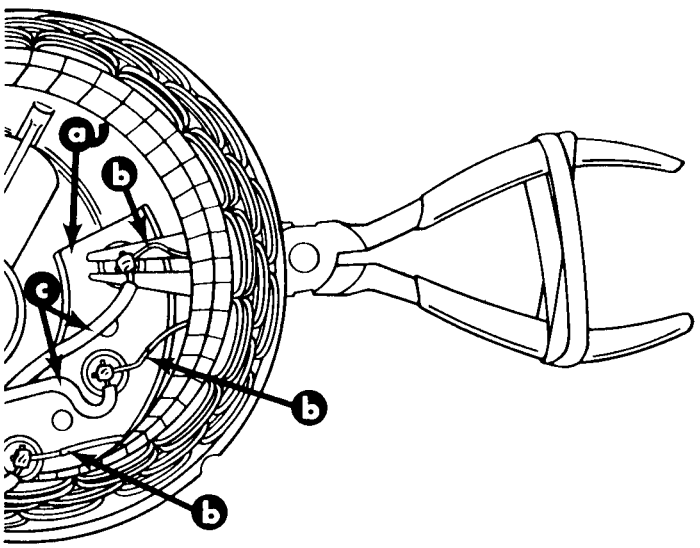
9. Unsolder diode trio lead from insulated regulator terminal.



a - Diode Trio
b - Diode Trio Lead
c - Insulated Terminal

Diode Trio Lead Removal

10. Unsolder the three (3) stator leads along with the three (3) coated leads from the negative (-) rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



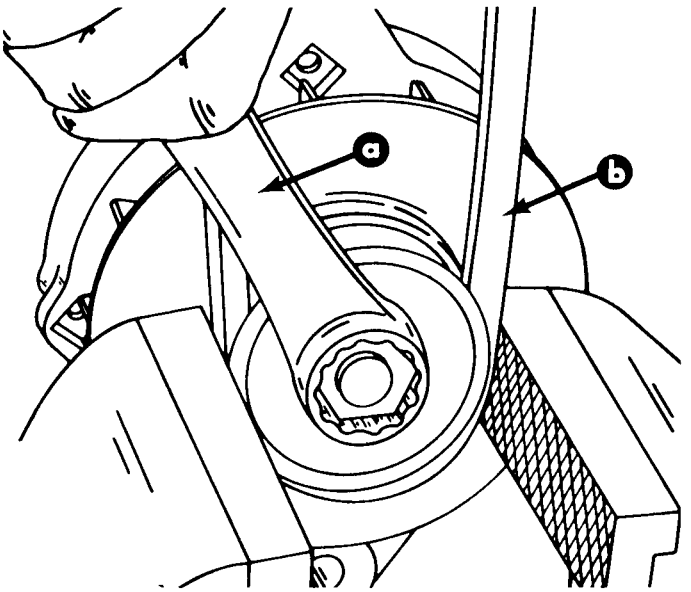
a - Negative (-) Heat Sink
b - Stator Leads (3)
c - Coated Leads (3) (2 Shown)

Unsoldering Leads from Negative (-) Rectifier Heat Sink

IMPORTANT: With alternator disassembled to this point, stator, rectifier diodes, diode trio and rotor may be tested, as explained under "Component Testing", following.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

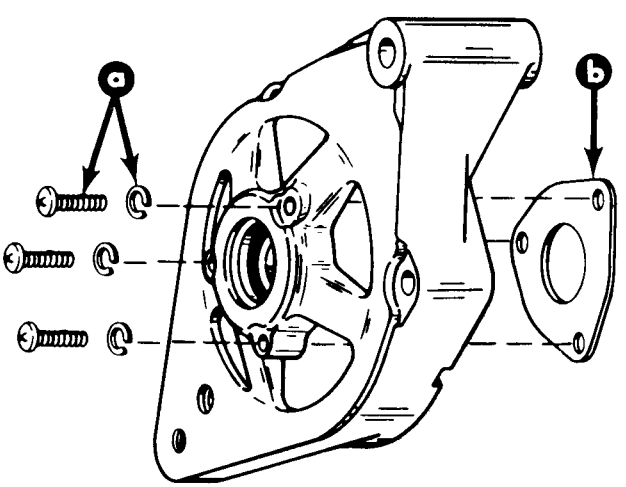
11. Remove pulley retaining nut by clamping pulley in a vise (using an oversize V-belt or protective jaws to protect pulley) and turning nut counterclockwise with a 7/8" wrench. Remove lockwasher and slide pulley and fan from shaft. If pulley is "stubborn", it may be necessary to use an universal pullers.



a - 7/8" Wrench
b - Use Oversize V-Belt to Protect Pulley

Removing Pulley Nut

12. Remove the (3) phillips head screws and lockwashers which secure the front bearing retaining plate.

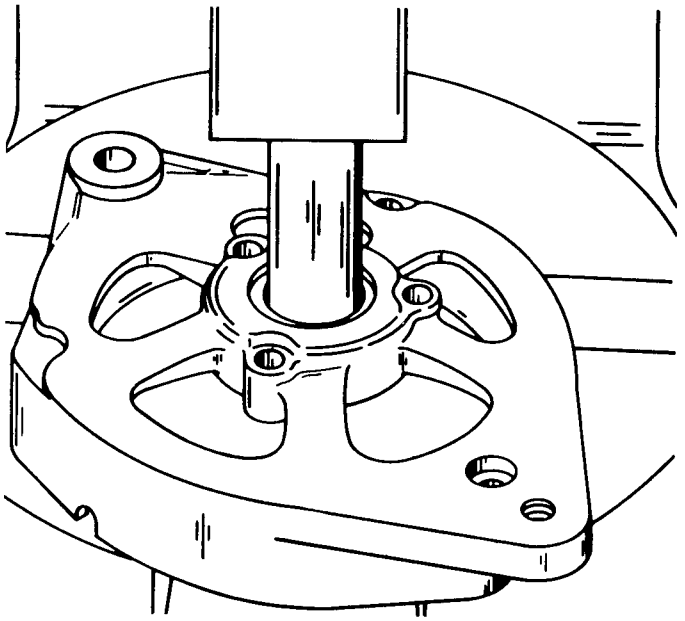


a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

Removing Front Bearing Retaining Plate

13. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. (Discard bearing).

14. If rotor slip rings or rear bearing require replacement entire rotor must be replaced. Parts cannot be purchased separately.



Removing Front Bearing from Front End Frame

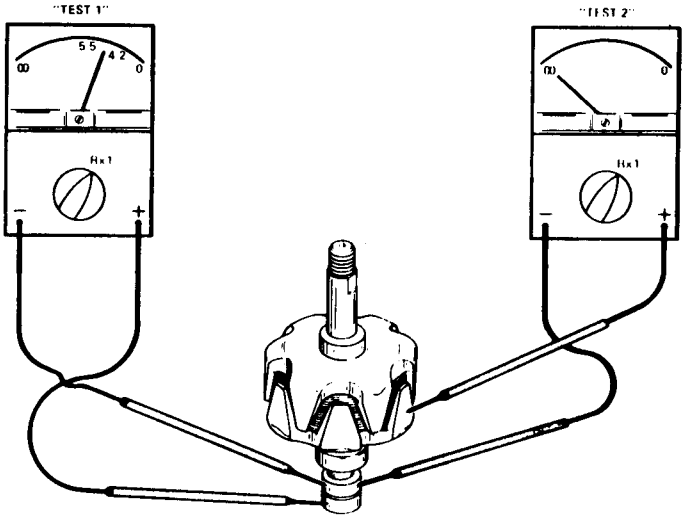
Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
   a. Brush set - inspect for cracked porcelain casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4" (6mm) long.
   b. Rotor - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. Rotor slip rings - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002" (.051mm) maximum] and replace, if present.
   d. Rotor shaft bearings - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. Stator - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration; as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. Regulator - inspect leads for damaged insulation.
   g. Front and rear end frames - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
   h. Fan - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).
   i. Pulley - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth, or drive belt wear will be greatly accelerated.

Component Testing

ROTOR

1. Test rotor field circuit for opens, shorts or high resistance (Test 1), using an ohmmeter (Set on Rx1 scale), as follows:



Testing Rotor Field Circuit

   a. Connect one ohmmeter lead to each slip ring.
   b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70°-80° F (21°-26° C).

c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.

2. Test rotor field circuit for grounds (Test 2, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity (meter should not move).

   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace motor assembly. If continuity is eliminated, replace slip rings.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

STATOR

IMPORTANT: Stator leads MUST BE disconnected from rectifier diodes and diode trio for this test.

1. Test stator for grounds (Test 1), using an ohmmeter (set on Rx1 scale) as follows:

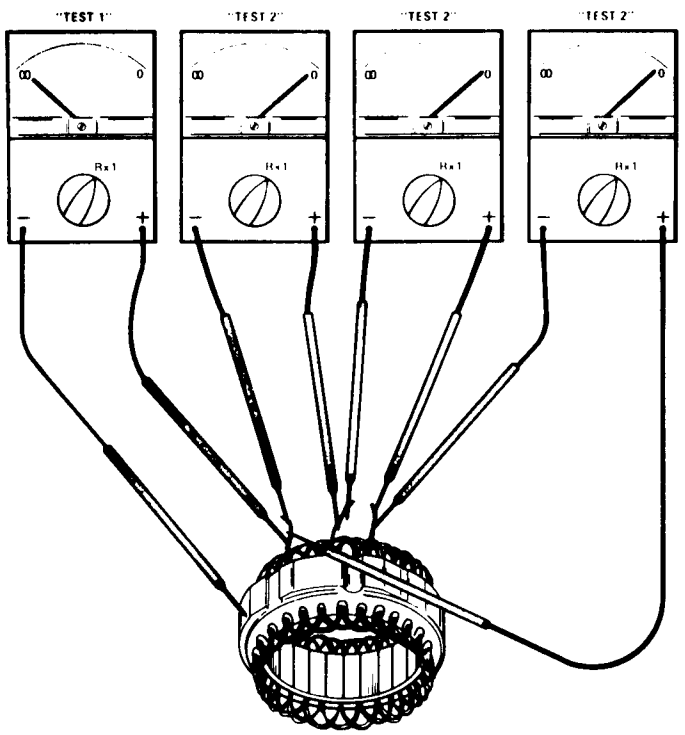
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.

2. Test for opens in stator, TEST 2 - using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect ohmmeter between each pair of stator windings (3 different ways).

   b. Continuity should be present in all 3 cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.



Testing Stator

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also examine stator for heat discoloration, as this usually is a sure sign of a short.

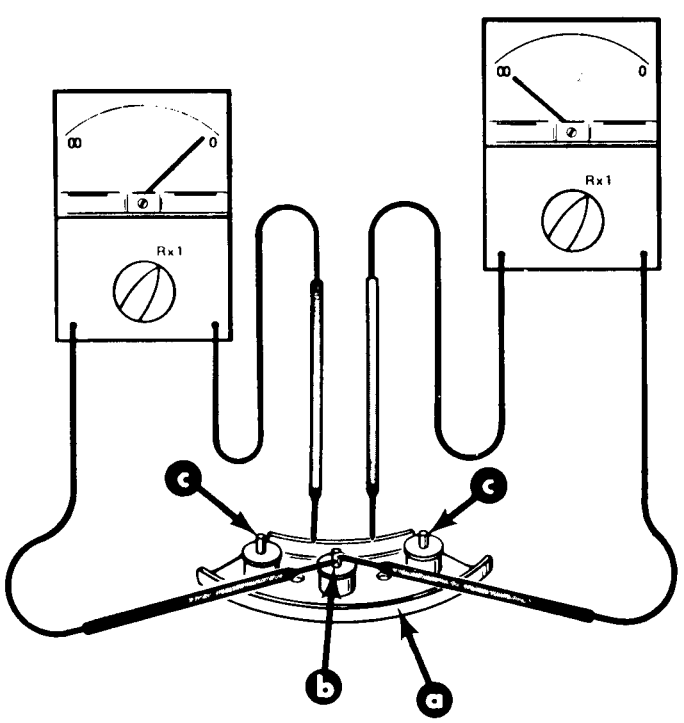
NEGATIVE (-) RECTIFIER DIODES

IMPORTANT: Rectifier diodes MUST BE disconnected from stator for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

1. Connect one lead of an ohmmeter (set on Rx1 scale) to negative (-) rectifier diode heat sink and the other lead to one of the rectifier diode terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.
5. Replace complete rectifier set, if any one of the diodes is shorted or open.



a - Heat Sink
b - Diode Terminal
c - Test These 2 Diodes in Same Manner

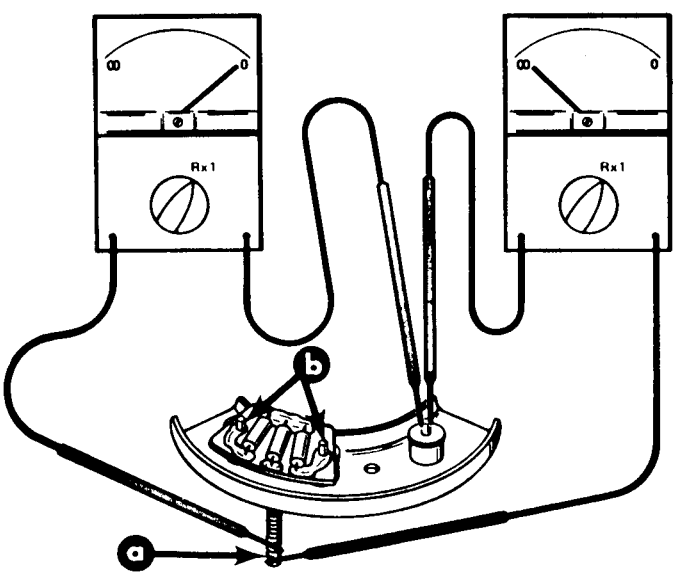
Testing Negative (-) Rectifier Diodes for Shorts or Opens

⚠CAUTION

DO NOT use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

POSITIVE (+) RECTIFIER DIODES AND DIODE TRIO

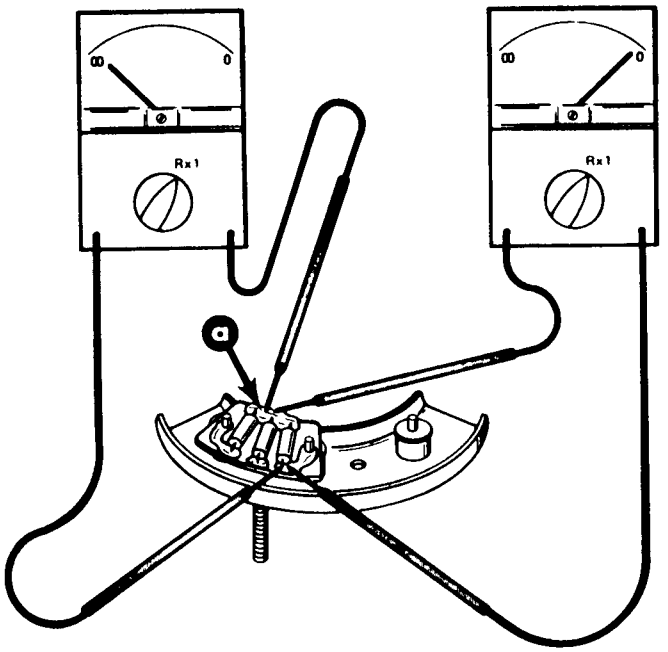
1. Connect one lead of an ohmmeter (set on Rx1 scale) to 1/4" stud on positive (+) rectifier heat sink and the other lead to one of the rectifier diode terminals. Note: Two of the diode terminals come up thru the diode trio circuit board). Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
4. Repeat Steps 1-thru-3 for 2 other rectifier diodes in heat sink.



a - Stud
b - Repeat Test Between These Terminals and Stud

Testing Positive (+) Rectifier Diodes for Shorts or Opens

5. Replace complete rectifier set, if any one of the diodes is shorted or open.
6. Connect one lead of an ohmmeter (set on Rx1 scale) to the common side on the diode trio circuit board and the other lead to the other side of one of the three (3) trio diodes.



a - Common Side of Diode Trio Circuit Board

Testing Diode Trio for Shorts or Opens

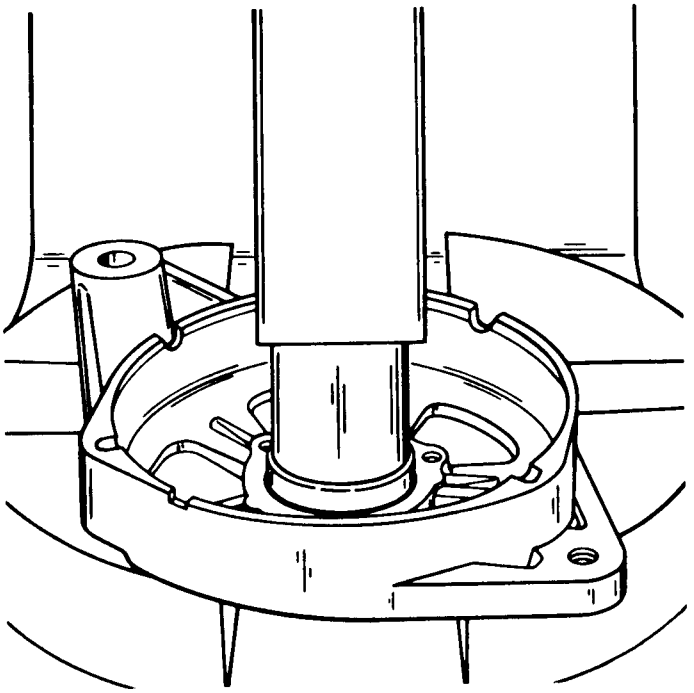
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode trio is open. If both readings are low, diode Trio is shorted.
9. Repeat Steps 6-thru-8 for the other 2 diodes.
10. Replace positive (+) rectifier and diode trio assembly if any one of the diodes is shorted or open.

CONDENSER

1. Using Magneto Analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd).
   b. Condenser Short or Leakage Test.
   c. Condenser Series Resistance Test.
2. Replace condenser, if test results are not within specifications.

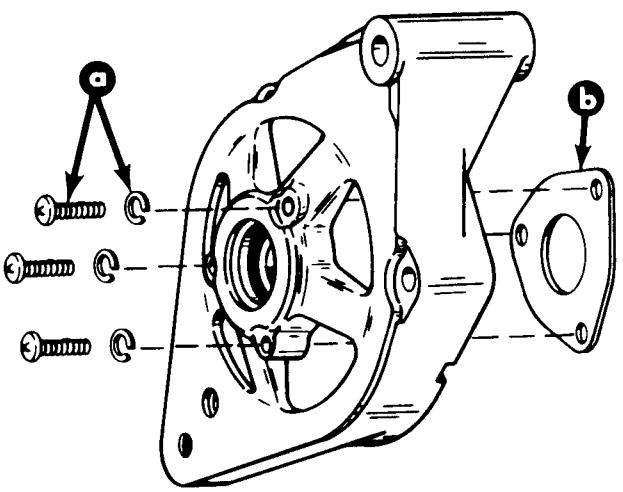
Reassembly

1. Install new front bearing into front end frame bearing bore using an arbor press. If necessary, use a bearing driver that contacts outer race only.



Installing Front Bearing into Front End Frame

2. Install front bearing retaining plate using 3 phillips head screws and lockwashers.



a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

Installing Front Bearing Retaining Plate

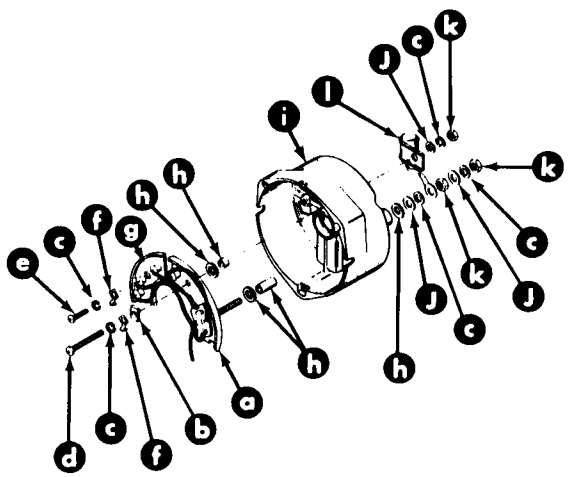
3. Slide front end frame over rotor.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

4. Slide fan spacer onto rotor shaft. Install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley, and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.

IMPORTANT: The insulating washers MUST BE installed as shown or damage to the alternator WILL result.

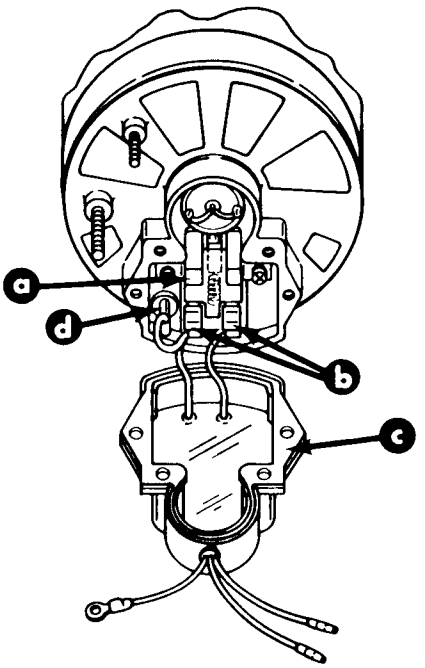
5. Install positive (+) and negative (-) rectifier heat sinks, shown.
6. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install screws. Tighten screws securely.



a - Positive (+) Rectifier Heat Sink
b - Rectangular Insulator
c - Lockwasher
d - Screw - 1-1/2" (38mm) Long
e - Screw - 1/2" (13mm) Long; 2 Required
f - Clip
g - Negative (-) Rectifier Heat Sink
h - Insulator
i - Rear End Frame
j - Flat Washer
k - Nut
l - Condenser

Installing Positive (+) and Negative (-) Rectifier Heat Sinks

7. Place brush set in rear end frame cavity and secure with 2 mounting screws, as shown. Be sure to use outermost mounting holes. Tighten screws securely.
8. Position rubber seal on regulator mounting surface. Connect regulator field leads and regulator lead to brush and regulator terminals (shown), then mount regulator with 4 screws. Connect ground terminal and secure with lockwashers and nuts. Tighten screws and nuts. securely.



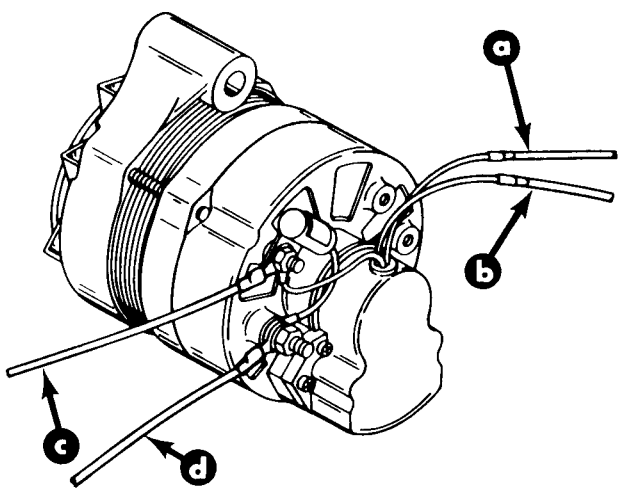
a - Brush Set (Use Outer Mounting Holes)
b - Be Sure to Connect Field Leads as Shown
c - Regulator Rubber Seal
d - Insulated Regulator Terminal

Installing Brush Set and Regulator

IMPORTANT: Regulator field leads MUST BE connected as shown, or leads may be damaged by rotor slip rings during operation.

Installation

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used), on each side of spacer. DO NOT tighten nut securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). DO NOT tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under "Drive Belt Tension Adjustment".
4. Reconnect wiring harness to alternator and negative battery cable to battery.

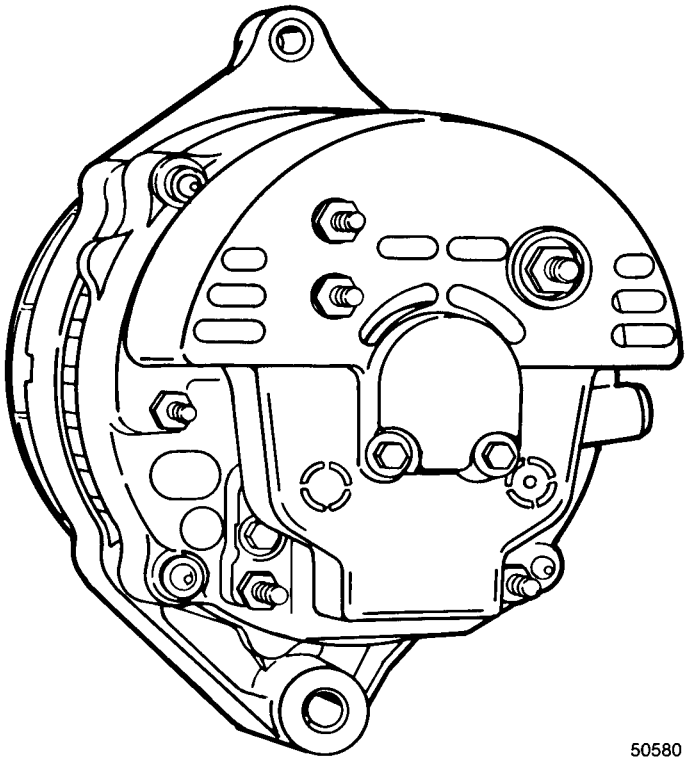


a - Excitation Lead (Purple)
b - Sensing Lead (Red/Purple)
c - Ground Lead (Black)
d - Output Lead (Orange)

Wiring Harness Connected to Alternator

Identification

Prestolite (Motorola)



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Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Prestolite (Motorola)-Alternator

Specifications

Voltage Output	13.8 - 14.8 Volts
Current Output	51 Amps
Excitation Circuit	1.5 - 3.0 Volts
Condenser Capacity	.5 MFD
Minimum Brush Length	3/16 in. (4.76mm)

Special Tools

Multi-Meter/DVA Tester	91-99750A1
Magneto Analyzer	91-76032

TOOLS PURCHASED LOCALLY

Ammeter (0-50 Amps)

Torque Specifications

Housing Screws	50 - 60 lb. in. (5.6 - 6.7 N.m)
Pulley Nut	35 - 50 lb. ft. (48 - 68 N.m)
Front Bearing Screws	25 -35 lb. in. (2.8 - 3.9 N.m)
Alternator Mount	35 lb. ft. (48 N.m)
Adjustment Bolt	16 lb. ft. (28 N.m)
Tighten All Other Fasteners Securely	
V-Belt Tension (Note 1)	Depress 1/2 in.

NOTE 1: Depress Belt With Thumb At Midway Point Between Circulating Pump Pulley and Alternator Pulley

Sealants

Liquid Neoprene	92-25711-2
Heat Sink Compound	Obtain Locally

Description

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven (via a pulley) at approximately twice engine speed. The rotor contains a field winding that is enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 6 diodes which are arranged so that current flows from ground, thru the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifier and stator. A capacitor also is utilized to protect the rectifier system from high voltages and to suppress radio noise.

Diagnosis on Engine

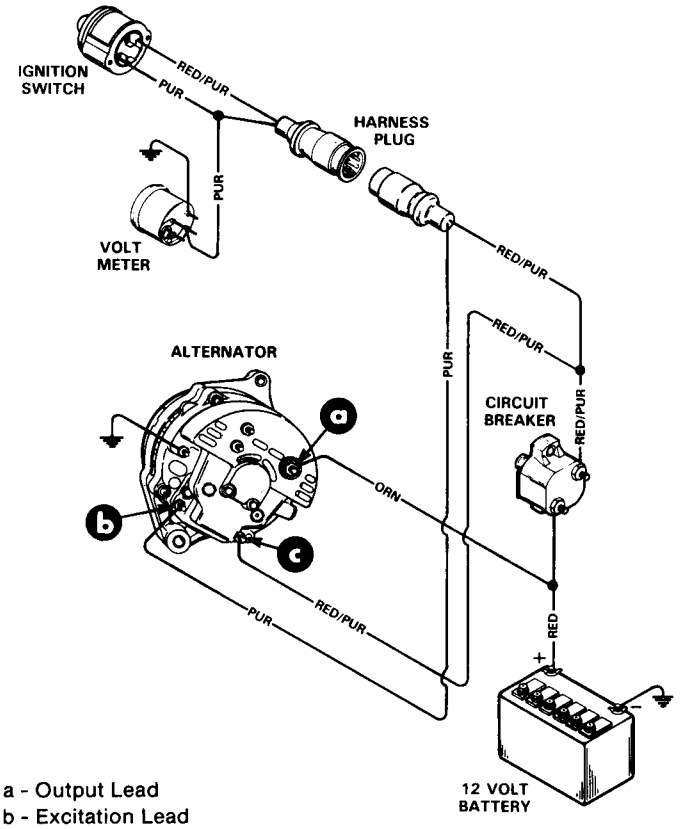
Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe "Precautions," immediately preceding, to prevent damage to alternator system.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt and replace if necessary. Also, check tension and adjust if necessary, as outlined under "Drive Belt Replacement and Adjustment."

System Components

The alternator system, used on engines with Prestolite Alternators consists of the alternator, battery, the ignition switch and the wiring which connects these components.

Typical Charging Circuit



a - Output Lead
b - Excitation Lead
c - Sensing Lead

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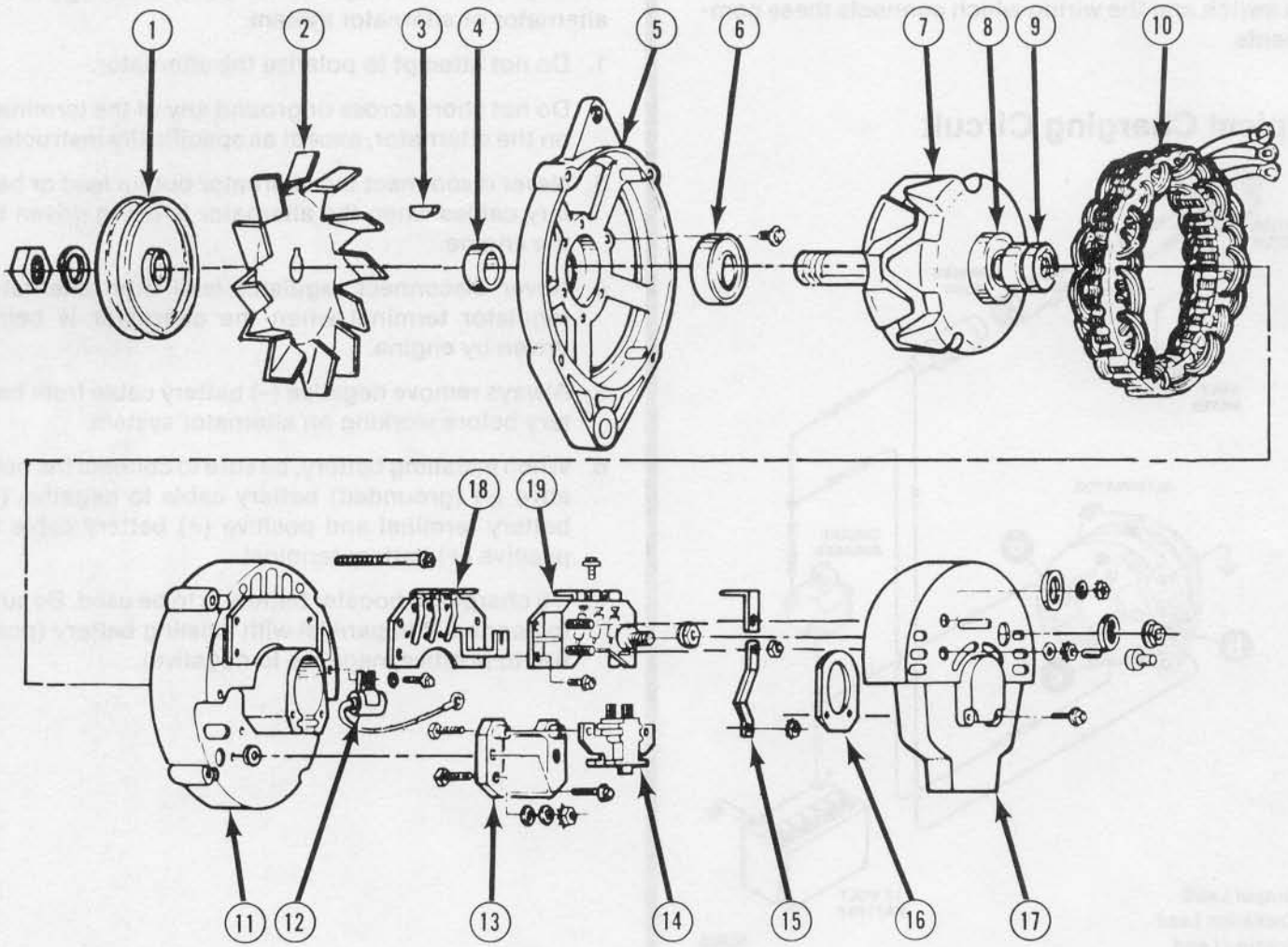
Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. Never disconnect regulator lead from alternator regulator terminal when the alternator is being driven by engine.
5. Always remove negative (-) battery cable from battery before working on alternator system.
6. When installing battery, be sure to connect the negative (-) (grounded) battery cable to negative (-) battery terminal and positive (+) battery cable to positive (+) battery terminal.
7. If a charger or booster battery is to be used. Be sure to connect it in parallel with existing battery (positive to positive; negative to negative).

Exploded View



1 - Pulley
2 - Fan
3 - Woodruff Key
4 - Fan Spacer
5 - Front Housing
6 - Front Bearing
7 - Rotor
8 - Rear Bearing
9 - Slip Rings
10 - Stator
11 - Rear Housing
12 - Capacitor
13 - Voltage Regulater
14 - Brush Assembly
15 - Strap
16 - Felt Gasket
17 - Cover
18 - Rectifier Bridge
19 - Diode Trio

Alternator/Regulator Tests

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

⚠WARNING
Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

Test No. 1 (Alternator Output Test)

Connect voltmeter to alternator output terminal (orange wire). With engine running about 1500 RPM and accessories (running light, radio, depth finder, etc.) turned on, voltage should be between 13.8 - 14.8. [Voltage may vary a few tenths of a volt (higher or lower) due to ambient temperature variations.]

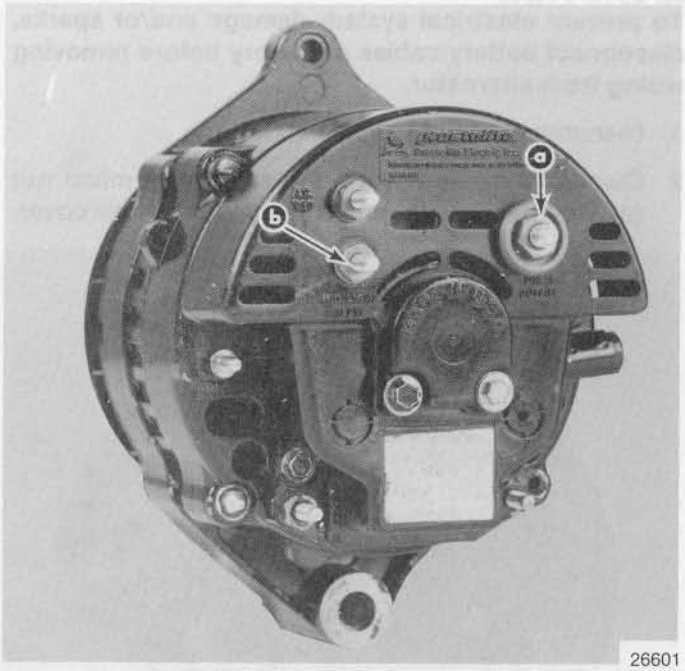
If voltage output does not fall within specifications, alternator should be disassembled for further inspection and tests.

Test No. 2 (Harness Voltage Test)

With ignition off, unplug red/purple wire and check for battery voltage at harness wire. No voltage at harness wire. No voltage indicates wiring harness is "open" and should be repaired or replaced.

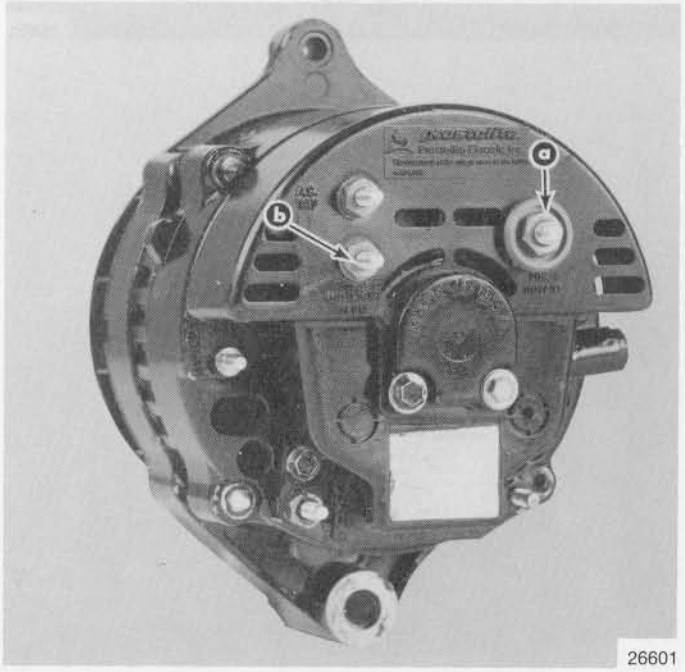
Test No. 3 (Open Diode-Trio Test)

1. With ignition on and engine not running, check for battery voltage at terminal (a) and 1.5 to 3.0 volts at termainal (b).



26601

2. Connect a jumper wire between terminal (a) and (b). Start engine and run at idle. If charging voltage (13.8 - 14.8 volts) is present at terminal (a), the diode-tri is probably defective and alternator should be removed for repair.



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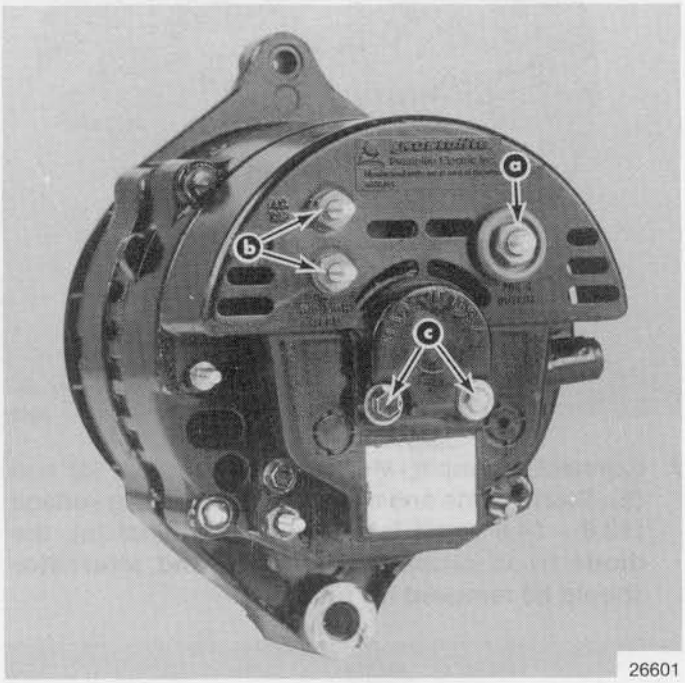
Test No. 4 (Open Regulator Test)

IMPORTANT: This test requires removal of back cover of alternator.

⚠CAUTION

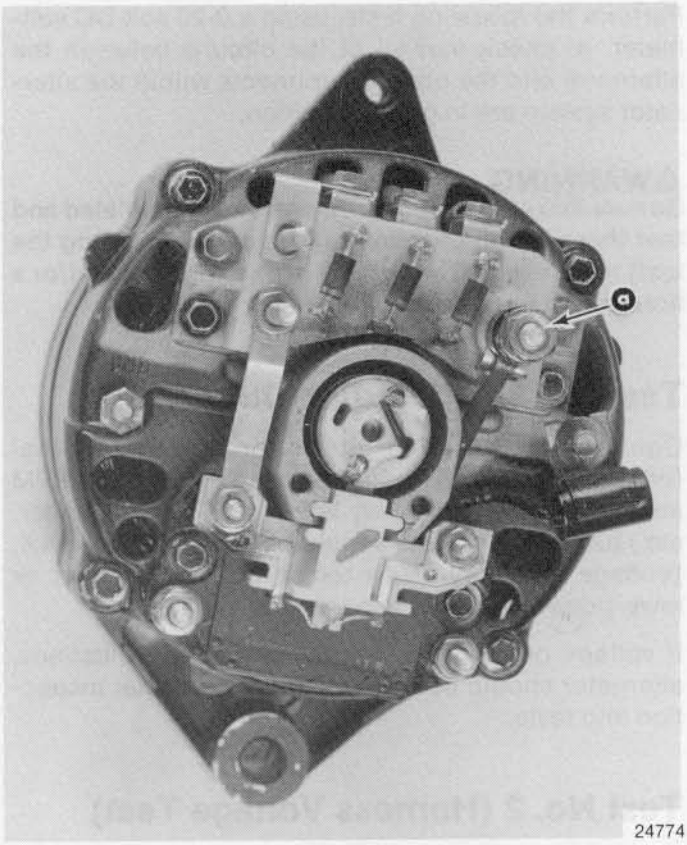
To prevent electrical system damage and/or sparks, disconnect battery cables at battery before removing wiring from alternator.

1. Disconnect battery cables at battery.
2. Disconnect output wire and remove terminal nut (a). Remove nuts (b) and screws (c). Remove cover.



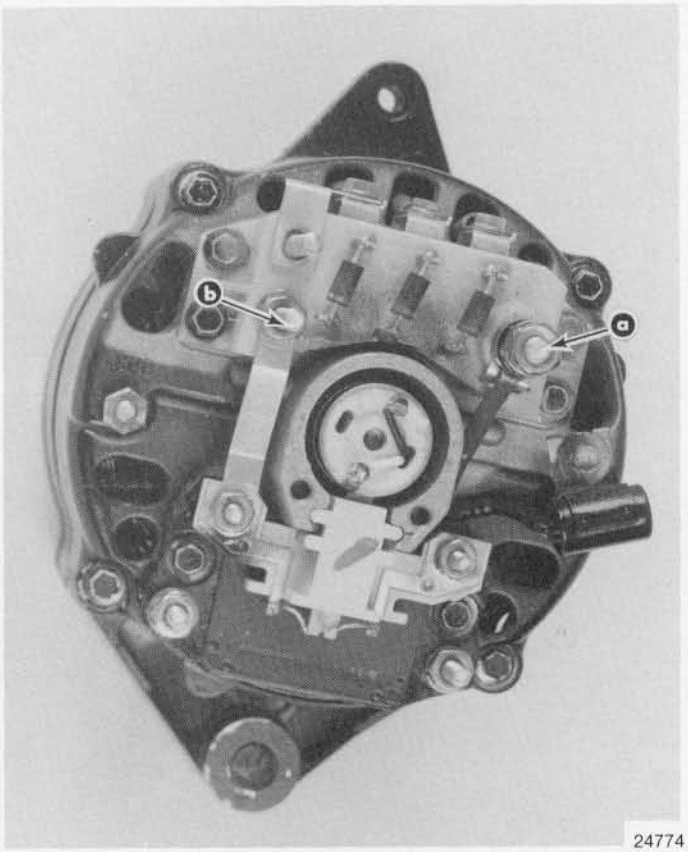
26601

3. Reconnect output wire on terminal (a). Reconnect battery cables.



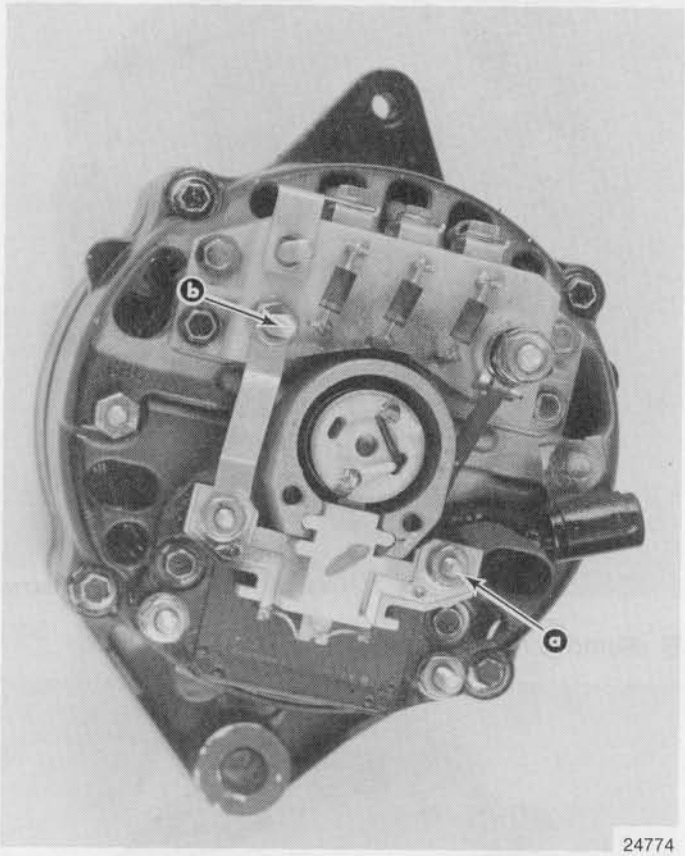
24774

4. With ignition switch on and engine not running, check for battery voltage at terminal (a) and terminal (b).



24774

5. Connect a jumper wire between field terminal (a) and ground. If 1.5 to 3.0 volts are present at terminal (b), regulator is defective. If voltage is not present at terminal (b), there is an open field circuit (brushes slip rings, etc.). Remove alternator for repair.



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Repair

⚠WARNING
Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

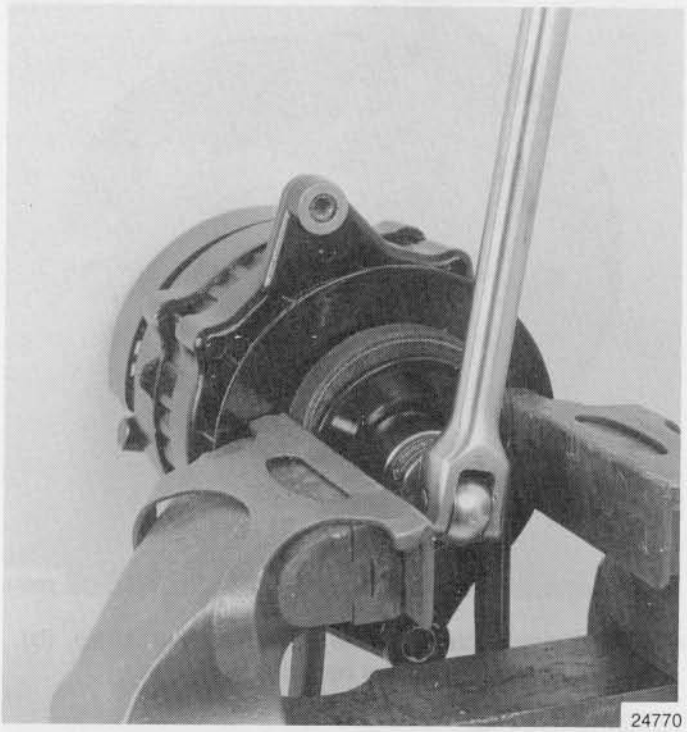
Removal

⚠CAUTION
To prevent sparks or damage to electrical system, disconnect battery cables at battery before removing alternator.

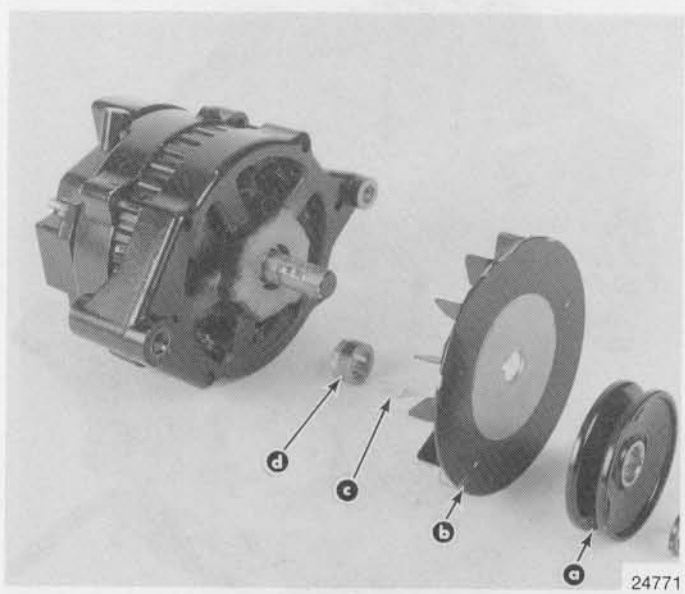
1. Disconnect battery cables from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator belt.
4. Remove alternator.

Disassembly

1. Using an oversized v-belt to protect the pulley, clamp alternator in vise as shown. Remove pulley nut.

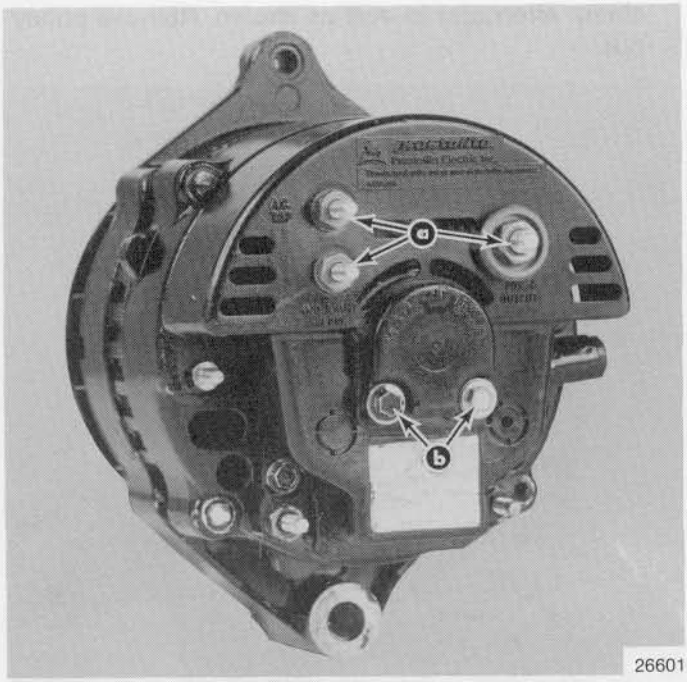

24770

2. Remove pulley (a), fan (b), woodruff key (c) and spacer (d).



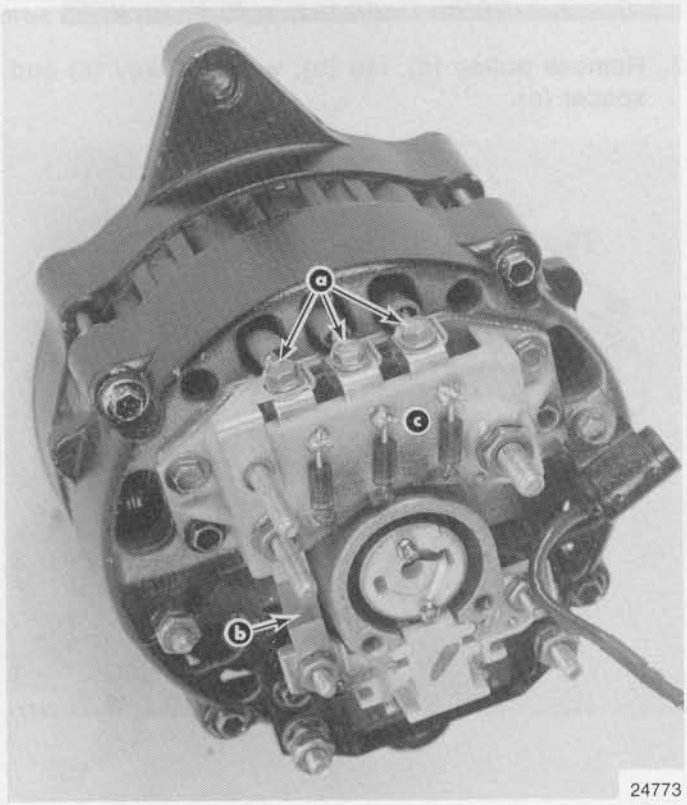
24771

3. Remove nuts (a) and screws (b) to remove rear cover.



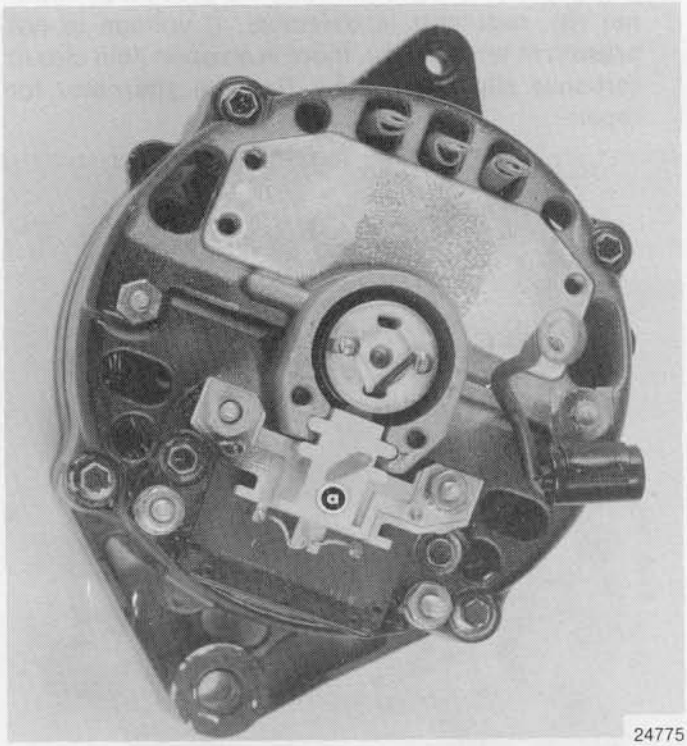
26601

4. Disconnect stator wires (a). Remove strap (b). Remove diode trio and rectifier bridge (c).



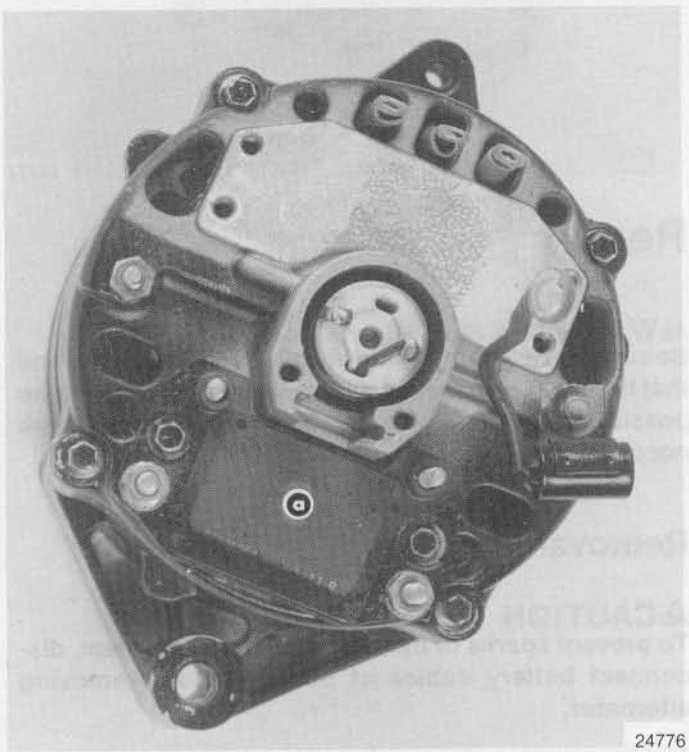
24773

5. Remove brush holder (a).



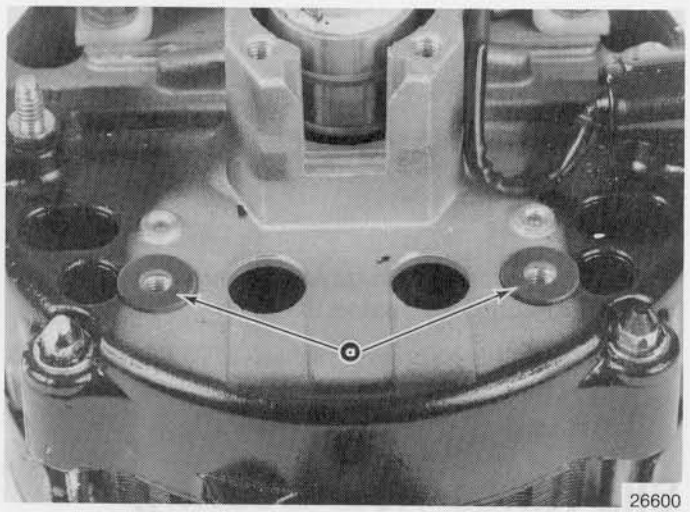
24775

6. Remove regulator (a).



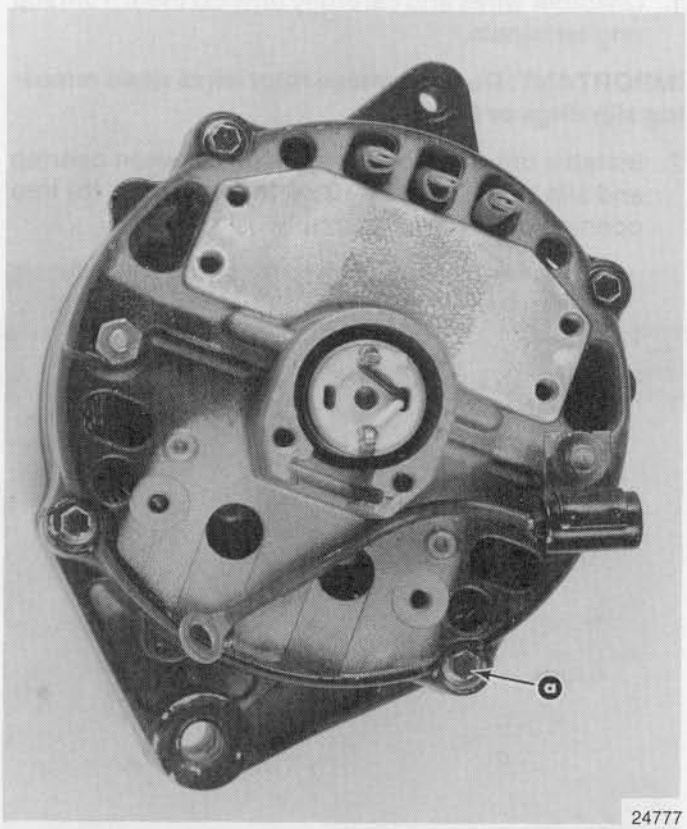
24776

IMPORTANT: Do not lose fiber washers (a).



26600

7. Mark front housing, stator, and rear housing for reassembly. Remove four (4) screws (a).

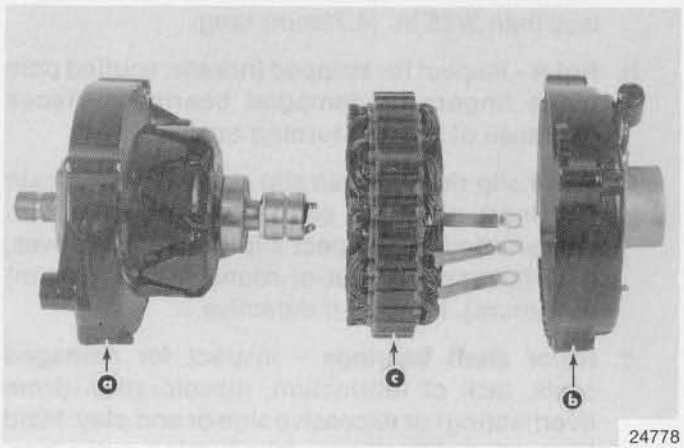


24777

8. Carefully insert two screwdriver blades in opposite openings between stator and front housing.

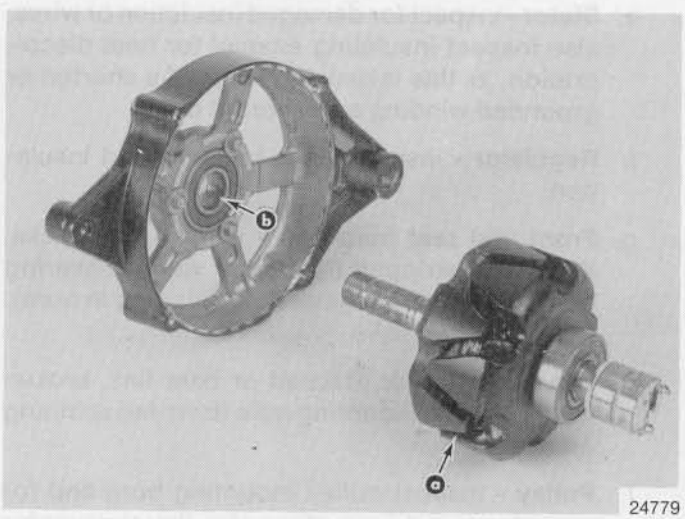
⚠CAUTION
Do not insert screwdriver blades deeper than 1/16 in. (1.58mm) to avoid damaging stator windings.

Pry front and rear housings, (a) and (b), from stator (c).



24778

9. While supporting front housing, use an arbor press to remove rotor (a) from front bearing (b).



24779

Inspection and Cleaning

1. Clean all parts with a clean, soft cloth. Do not use solvent, or electrical components may be damaged.
2. Inspect the following:

   a. **Brush set** - inspect for cracked porcelain casing, damaged brush leads, poor brush springs or worn brushes. Replace brush set if brushes are less than 3/16 in. (4.76mm) long.

   b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).

   c. **Rotor slip rings** - clean slip rings with 400 grain (or finer) polishing cloth. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002" (.05mm) maximum]. Replace if defective.

   d. **Rotor shaft bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.

   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.

   f. **Regulator** - inspect leads for damaged insulation.

   g. **Front and rear housings** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). Replace if defective.

   h. **Fan** - inspect for cracked or bent fins, broken welds or worn mounting hole (from fan spinning on shaft).

   i. **Pulley** - inspect pulley mounting bore and for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley. Drive surfaces must be true and smooth, or drive belt wear will be greatly accelerated.

   j. **Alternator** - if alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, because of centrifugal force. Replace rotor, if all other electrical components test good.

Front Bearing

Removal

1. Remove retaining screws.
2. Use an arbor press to remove bearing from housing.

Installation

1. Using an arbor press, press on outer race of new bearing until fully seated in housing.
2. Install retaining screws. Tighten to 25 - 35 lb. in. (2.8 - 3.9 N.m).

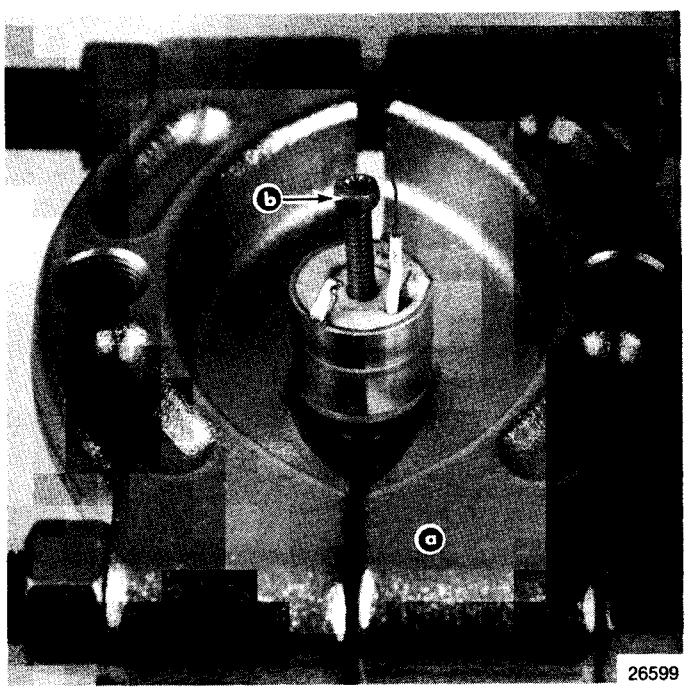
Slip Rings/Rear Bearing

Removal

1. Unsolder wires and carefully unwind them from slip ring terminals.

IMPORTANT: Do not damage rotor wires when removing slip rings or bearing.

2. Install a universal puller plate (a) between bearing and slip rings. Insert a 10 x 1 in. cap screw (b) into opening of slip ring assembly.



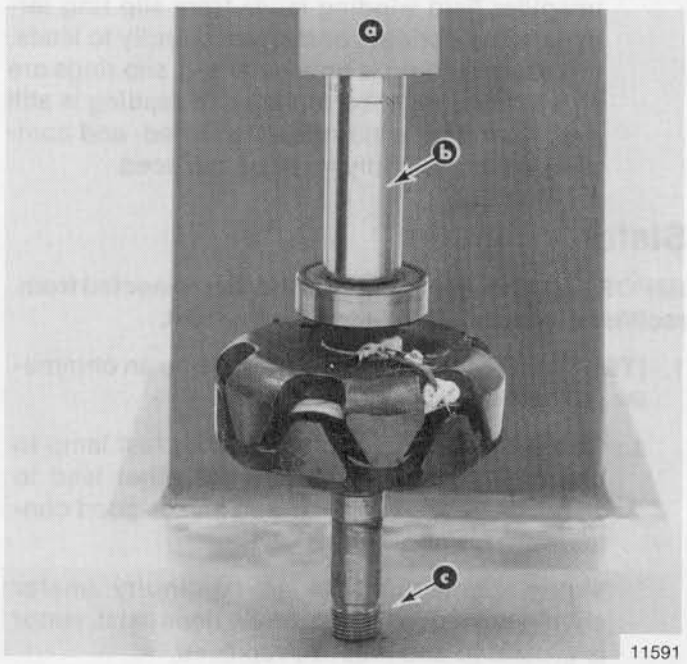
26599

3. Using an arbor press, push against cap screw to remove slip rings.
4. Install a universal puller plate under bearing.
5. Using an arbor press, remove bearing.

Installation

1. Press new rear bearing all-the-way onto rotor shaft (until inner race contacts shoulder) with an arbor press and a bearing driver that contacts inner bearing race only, as shown. Use extreme care to prevent damage to field winding leads.

IMPORTANT: Be sure to support rotor on end of shaft and not on pole pieces, as pole pieces are only press-fit onto shaft.



11591

a - Arbor Press
b - Bearing Driver (Must Contact Inner Bearing Race Only)
c - Support Pulley End of Shaft on Arbor Press Base (DO NOT Support Rotor on Pole Pieces

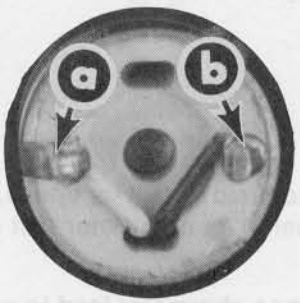
2. Insert wires thru hole in slip rings as shown.

26598

IMPORTANT: Press on the center of slip rings only. Do not bend terminals or pinch wires.

3. Using an arbor press, install slip rings. Press on center of slip rings until they contact shoulder of rotor.

4. Carefully wrap white wire around outer slip ring terminal (a) and black wire around inner slip ring terminal (b). Solder wires in place.



24777

Component Testing

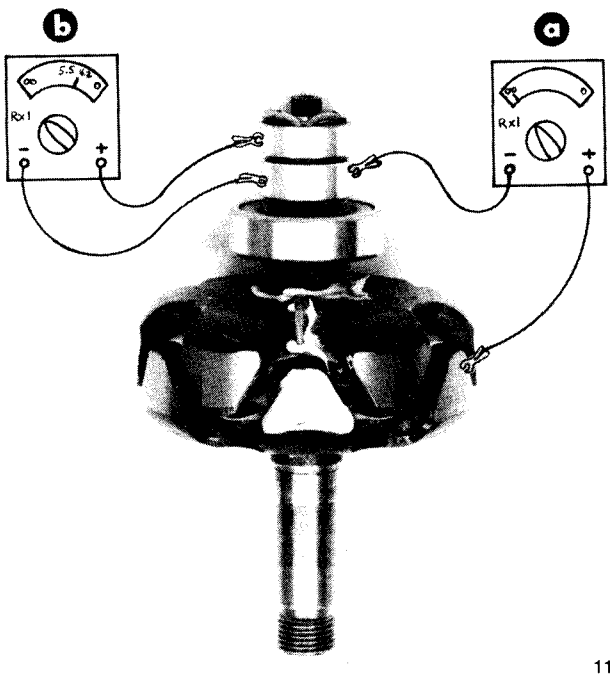
Rotor

1. **(TEST 1),** rotor filed circuit for grounds, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity (meter should not move).

   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.



11587

2. **(TEST 2),** rotor field circuit for opens, shorts or high resistance, using an ohmmeter (set on Rx1 scale), as follows:

   a. Connect one ohmmeter lead to each slip ring.

   b. Ohmmeter reading should be 4.1 to 4.7 ohms with rotor at room temperature [70° - 80° F (21° -26° C)].

   c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, replace slip rings. If reading is still high or infinite, replace complete rotor assembly.

   d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, slip rings are shorted and must be replaced. If reading is still low, rotor field windings are shorted, and complete rotor assembly must be replaced.

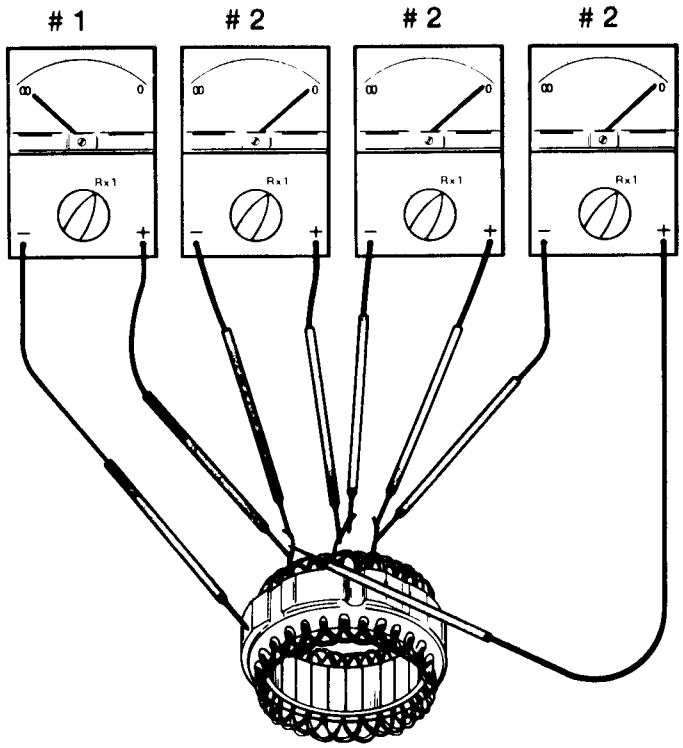
Stator

IMPORTANT: Stator leads must be disconnected from rectifier diodes and diode trio for this test.

1. **(TEST 1),** Test stator for grounds, using an ohmmeter (set on Rx1 scale) as follows:

   a. Connect one lead of ohmmeter or test lamp to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

   Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



2. **(TEST 2),** for opens in stator, using an ohmmeter (set on Rx1 scale) as follows:

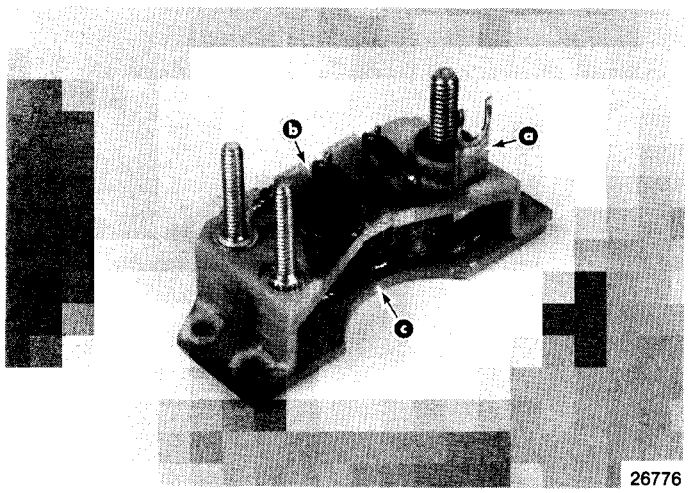
   a. Connect ohmmeter or test lamp betweeen each pair of stator windings (3 different ways). Either of the 2 leads (coming from each stator windings may be used).

      Continuity should be present in all 3 cases (meter should move); if it does not, one or more of the windings are open and stator must be replaced.

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discolorations, as this usually is a sign of a short.

Rectifier Bridge/Diode Trio Assembly

Straighten strap (a) as shown. Pull diode trio (b) and rectifier bridge (c) apart.



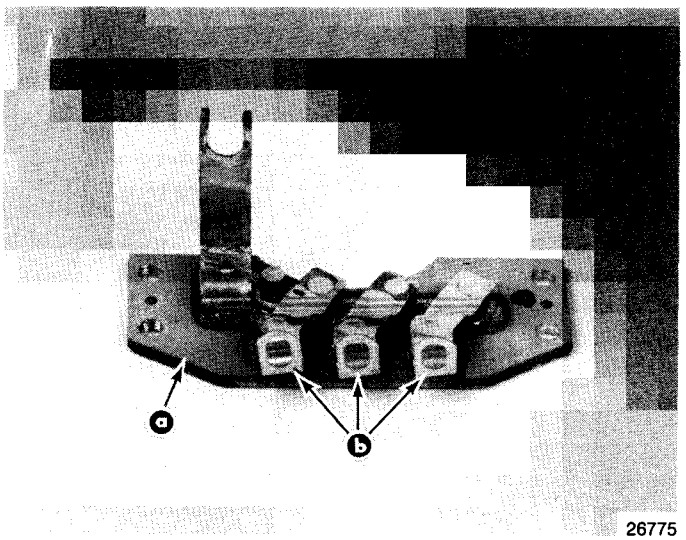
26776

⚠CAUTION
Do not use a test instrument with more than a 12-volt source (in the following test), as rectifier diodes may be damaged.

IMPORTANT: Rectifier diodes must be disconnected from stator for this test.

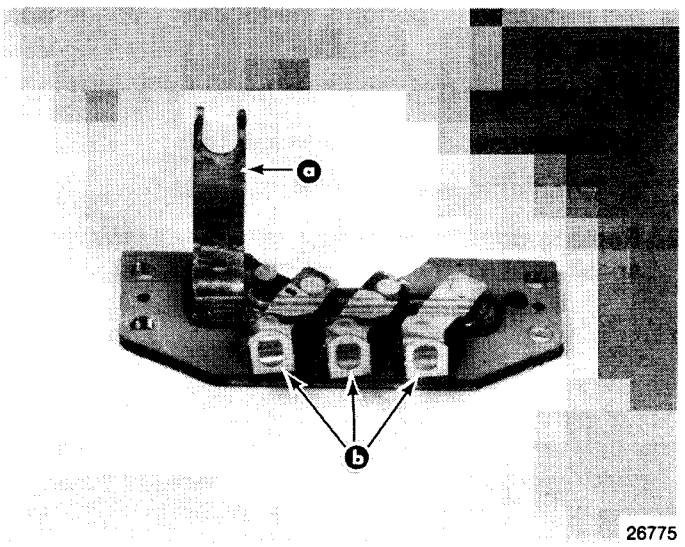
Rectifier Bridge

1. Using an ohmmeter (set on Rx1 scale), check for continuity between point (a) and each diode (b). Switch ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only, and all diodes should check alike.



26775

2. Using an ohmmeter (set on Rx1 scale), check for continuity between strap (a) and each diode (b). Switch ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only, and all diode should check alike.

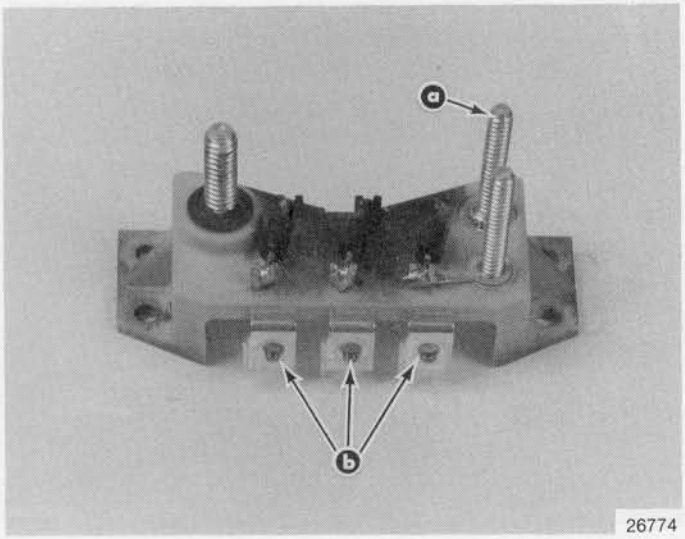


26775

If any diode is defective, replace entire rectifier bridge.

Diode Trio

1. Using an ohmmeter (set of Rx1 scale), check for continuity between stud (a) and each terminal (b). Switch ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only, and all diodes should check alike.



If any diode is defective, replace entire diode trio.

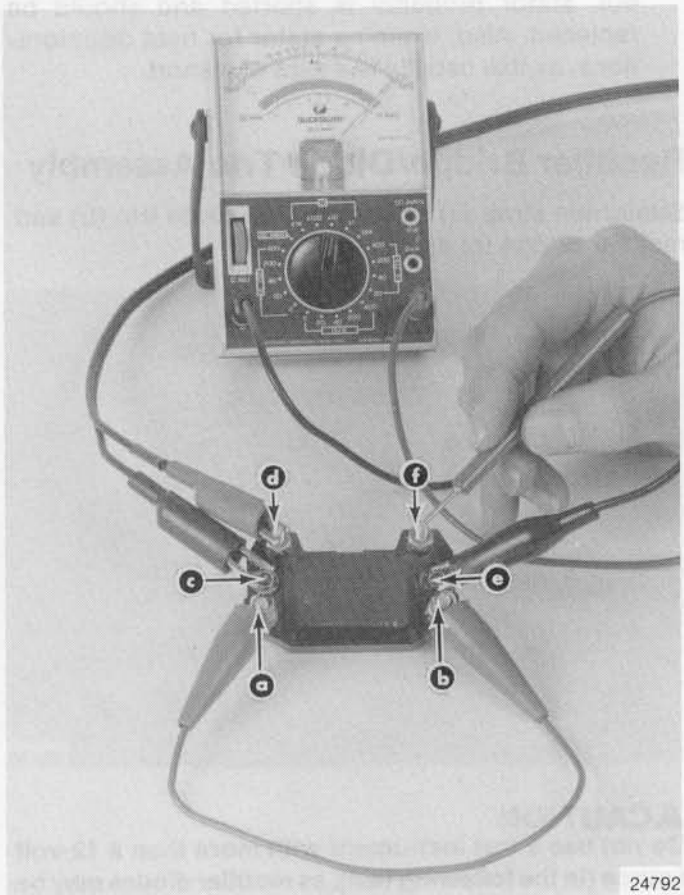
Condenser

1. Using Magneto Analyzer 91-76032 and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser, if test results are not within specifications.

Voltage Regulator Test

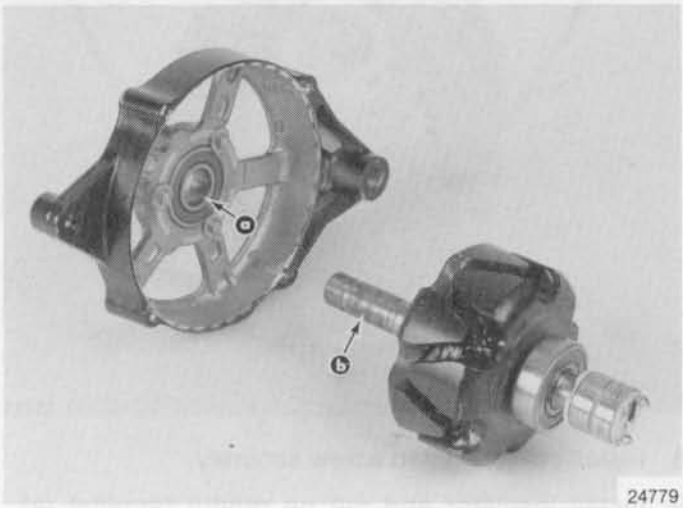
The voltage regulator can be tested using jumper wires, an ohmmeter and a variable voltage power supply (0-20 Volts DC).

Connect a jumper wire across terminals (a) and (b). Connect the negative (-) power supply lead to terminal (c) and the positive (+) power supply lead to terminal (d). With the ohmmeter set on x10 scale, check for no resistance between negative terminal (e) and positive terminal (f) with power supply at less than 12 volts. Resistance should increase when voltage is increased to over 14 volts. If resistance doesn't increase, reverse ohmmeter leads and test again before determining that regulator is defective.



Assembly

1. Using an arbor press, install front housing with bearing (a) on rotor (b). Press only on center race of bearing until it contacts shoulder of rotor.



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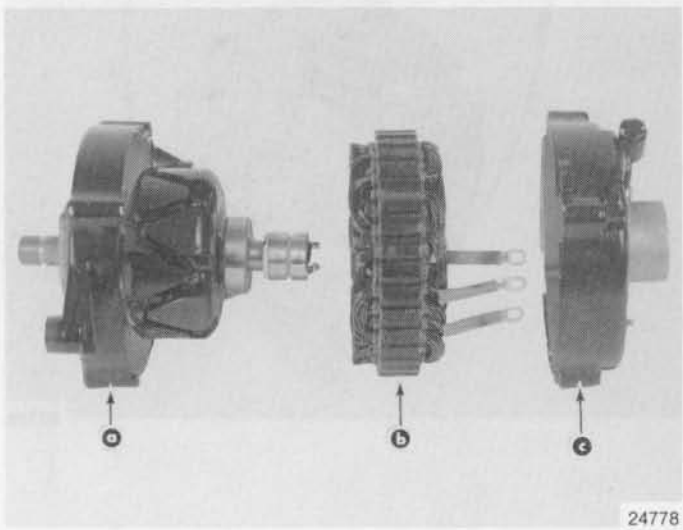
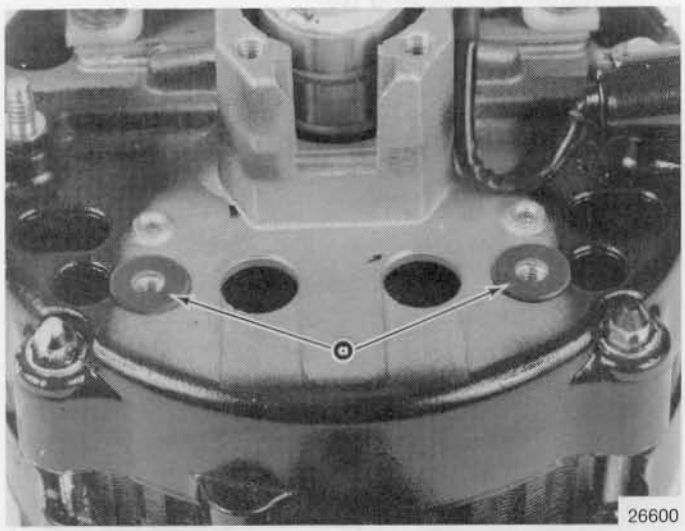
2. Aligning marks made during disassembly, assemble front housing (a), stator (b) and rear housing (c). Tighten screws to 50-60 lb. in. (5.6-6.7 N.m).



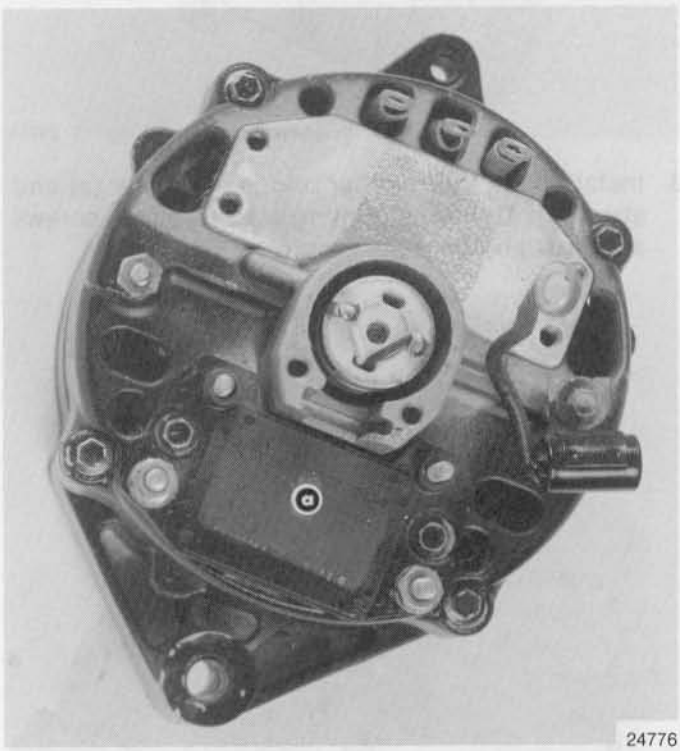
24778

3. Set fiber insulating washers (a) in place on rear housing.



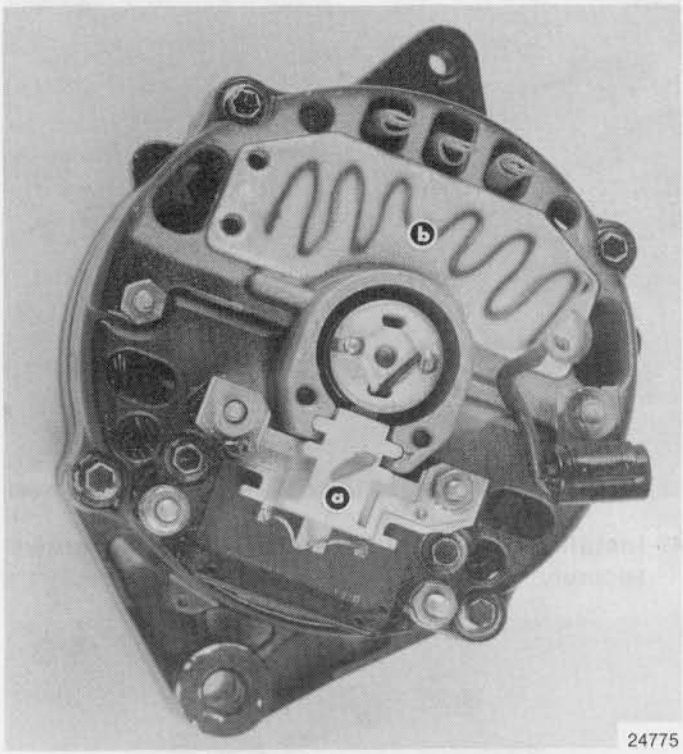
26600

4. Install voltage regulator (a). Tighten screws securely.



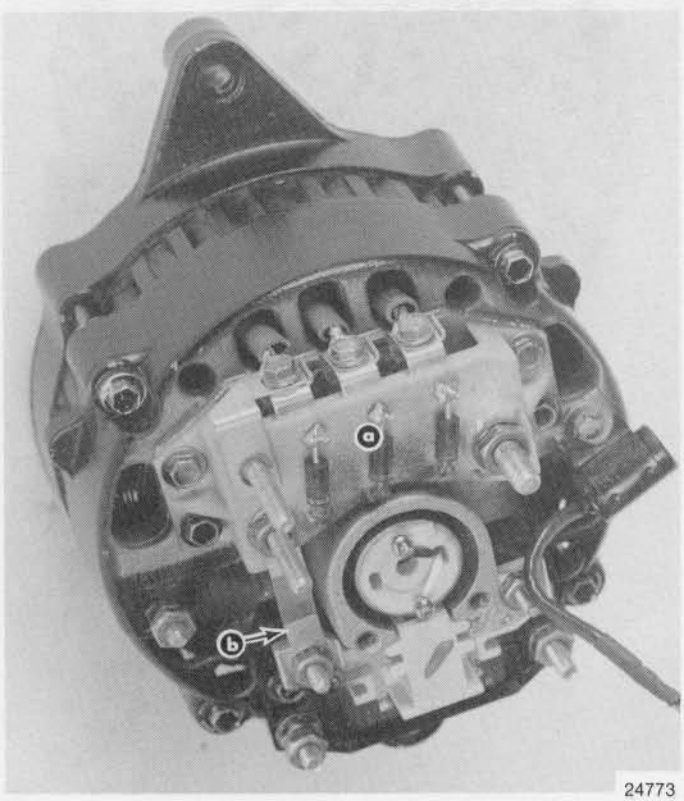
24776

5. Install brush holder (a) with only right side mounting nut finger tight. Apply a thin coating of heat sink compound to housing (b).



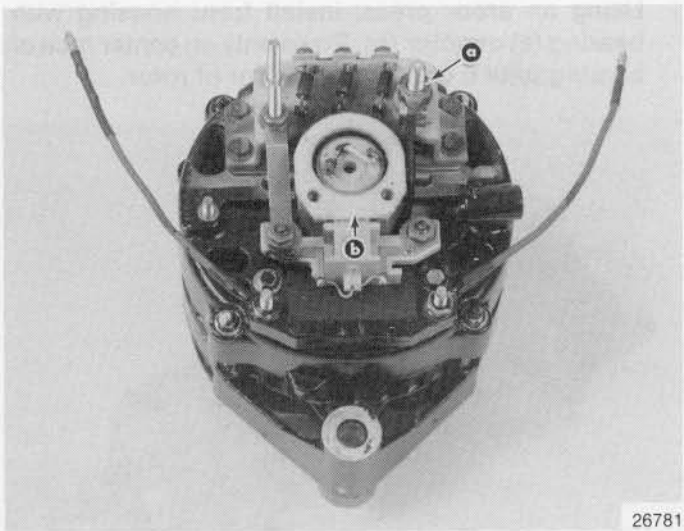
24775

6. Install diode trio/rectifier bridge assembly (a) and strap (b). Tighten mounting screws, stator screws and brush holder nuts securely.



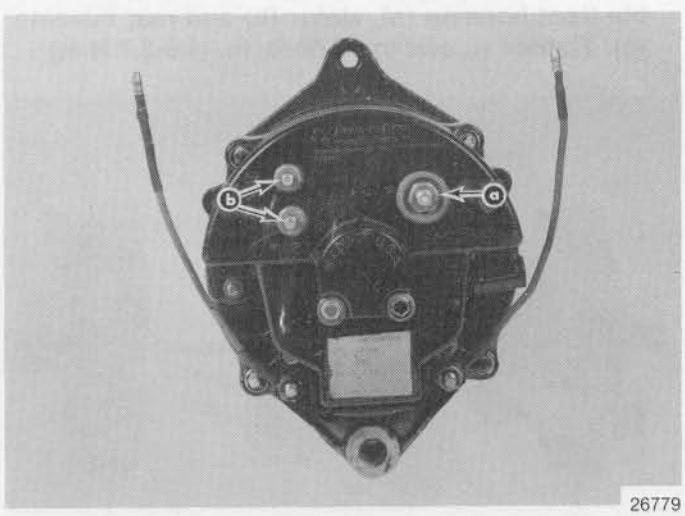
24773

7. Place condenser lead (a) on output terminal and felt gasket (b) on rear housing.



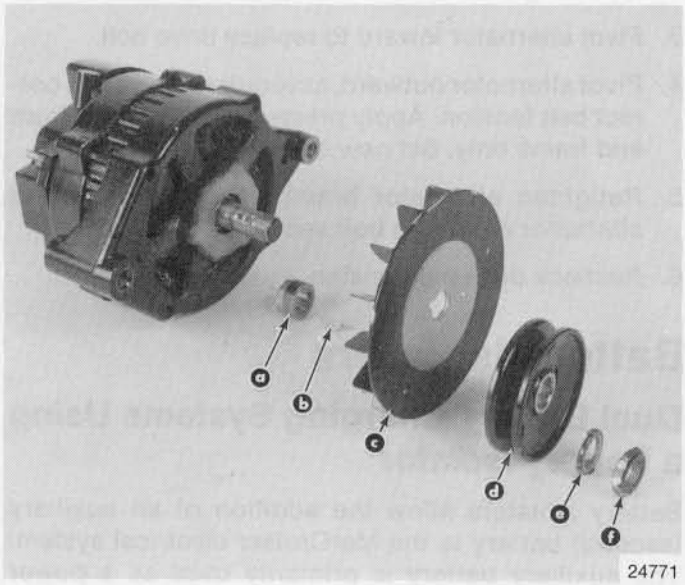
26781

8. Install cover, tighten screw securely.
9. Install insulator and nut on output terminal (a). Install nuts (b). Tighten all nuts securely.



26779

10. Install spacer (a), woodruff key (b), fan (c), pulley (d), lock washer (e) and nut (f).



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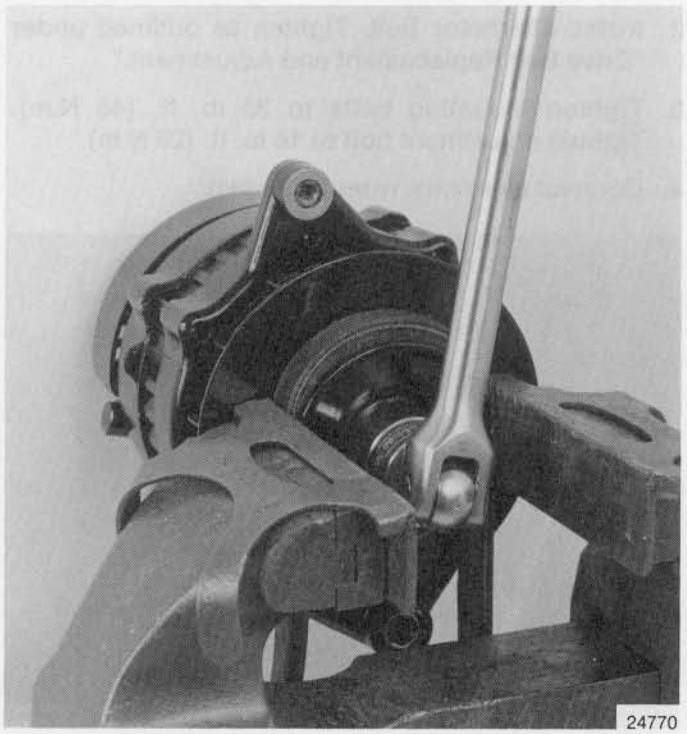
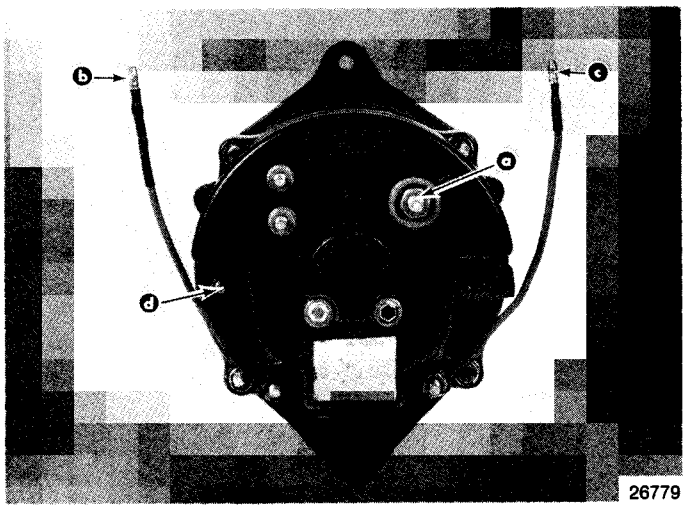
11. Using an oversized belt to protect the pulley, clamp alternator in vise as shown. Tighten pulley nut to 35-50 lb. ft. (48-68 N.m).


24770

Installation

1. Install alternator on engine.
2. Install alternator Belt. Tighten as outlined under "Drive Belt Replacement and Adjustment."
3. Tighten mounting bolts to 35 lb. ft. (48 N.m). Tighten adjustment bolt to 16 lb. ft. (28 N.m).
4. Connect alternator wires as shown.



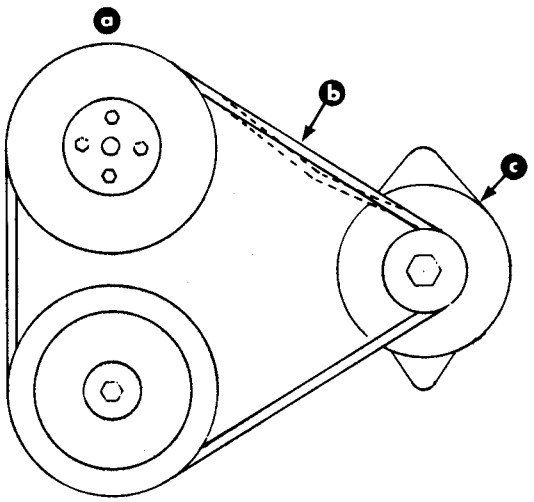
a - Orange
b - Purple
c - Red/Purple
d - Black

5. Connect battery cables to battery.

Drive Belt Replacement and Adjustment

IMPORTANT: When adjusting drive belt tension do not apply pressure to alternator rear end frame, as alternator may be damaged.

1. Check belt tension by depressing belt with thumb at midway point. Belt should depress 1/2 in. (13mm).



a - Circulating Pump Pulley
b - Check Point
c - Alternator

2. If adjustment or replacement is necessary, loosen alternator brace attaching bolts and alternator mounting bolt.
3. Pivot alternator inward to replace drive belt.
4. Pivot alternator outward, as required, to obtain correct belt tension. Apply pressure to alternator front end frame only. Set new belts at high reading.
5. Retighten alternator brace attaching bolts and alternator mounting bolt securely.
6. Recheck drive belt tension.

Battery Isolators

Dual Battery Charging Systems Using a Battery Isolator

Battery isolators allow the addition of an auxiliary (second) battery to the MerCruiser electrical system. The auxiliary battery is primarily used as a power source for various accessories installed on the boat. The battery isolator will allow the alternator to charge both the cranking and auxiliary batteries at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

Mercury Marine does not manufacture any battery isolator systems. Battery isolators must be bought from an outside manufacturer. Mercury Marine suggests following the manufacturers instruction carefully.

IMPORTANT: Alternators used on MerCruiser engines ARE NOT equipped with an isolation diode.

⚠CAUTION

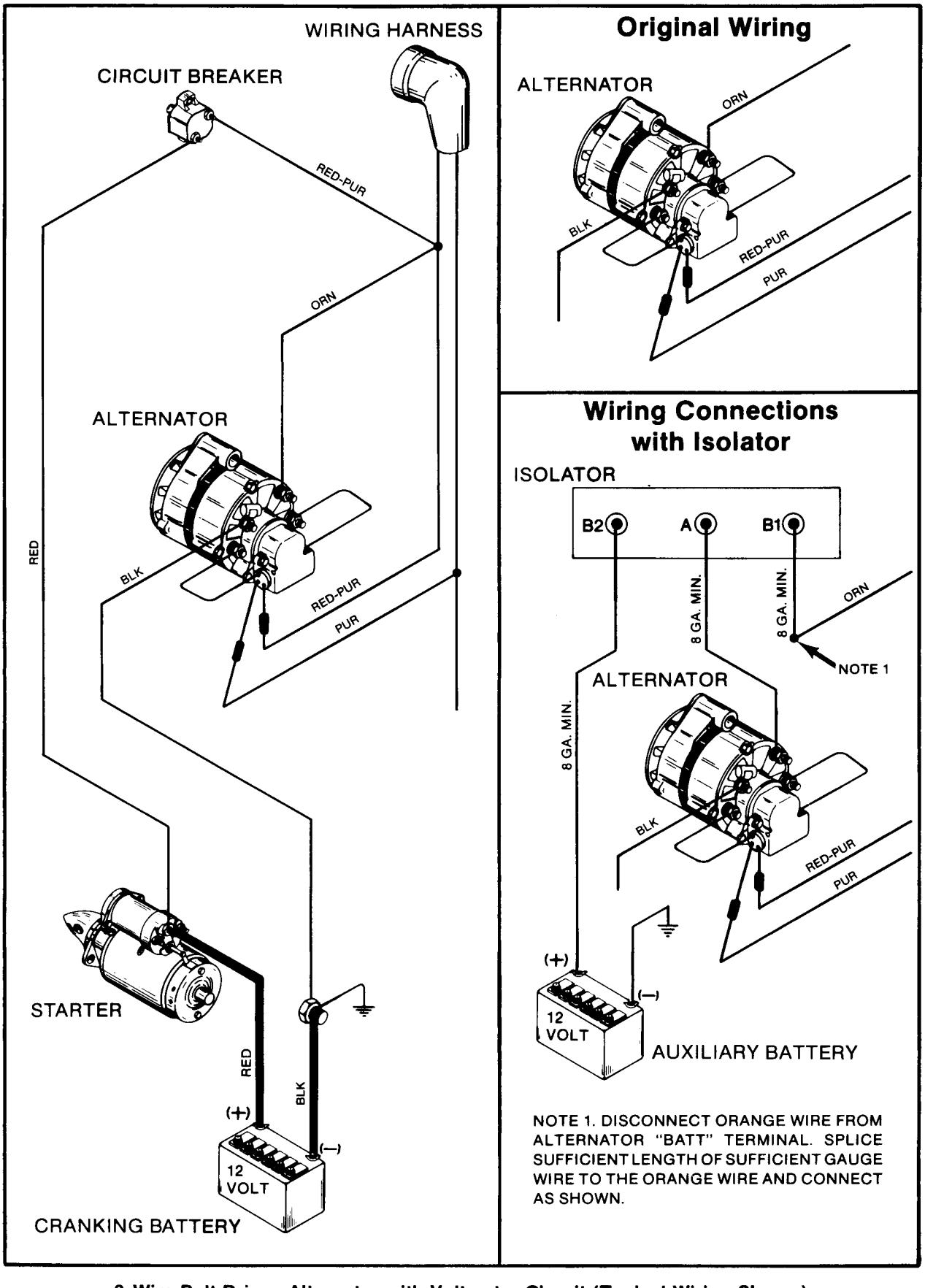
Follow battery isolator manufacturer's instructions for wire gauge. Battery isolator installation must conform to BIA Low Voltage Wiring Standard No. 125-79.

MerCruiser engines that meet the following requirements can use a battery isolator.

All Other Models

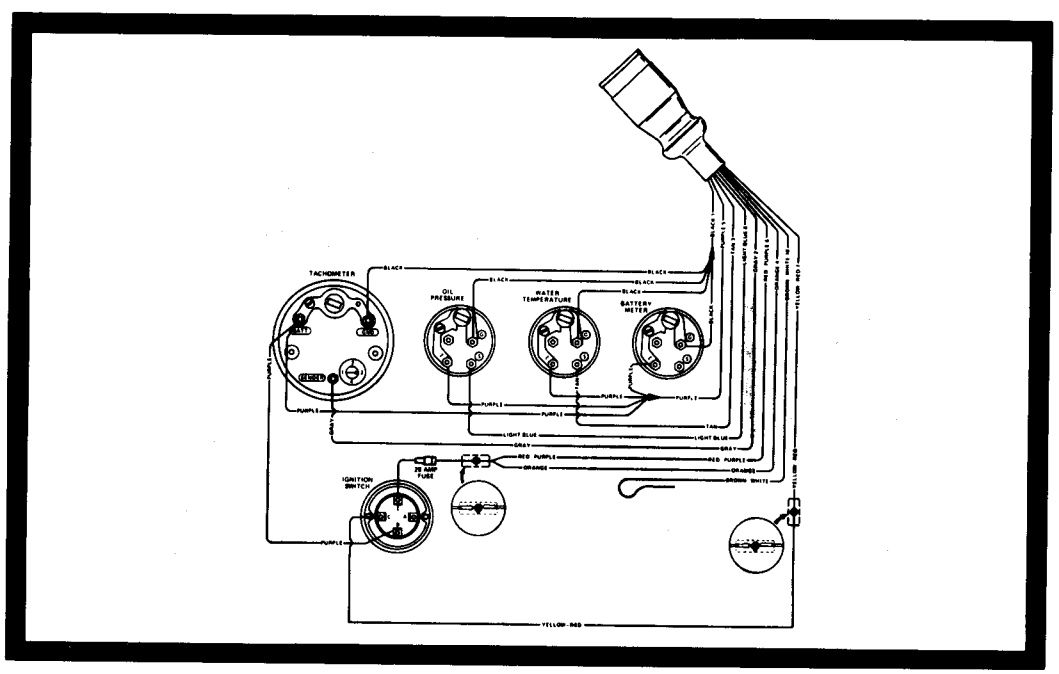
1. All engines equipped with a 3-wire belt driven alternator.
2. We recommend 1-wire Delco alternators be replaced with a 3-wire belt driven alternator (78403A2) before installing a battery isolator.
3. Following is a suggested wiring installation for MerCruiser models.

BLK = BLACK	PUR = PURPLE
BLU = BLUE	RED = RED
BRN = BROWN	TAN = TAN
GRY = GRAY	WHT = WHITE
GRN = GREEN	YEL = YELLOW
ORN = ORANGE	LIT = LIGHT
PNK = PINK	DRK = DARK



3-Wire Belt Driven Alternator with Voltmeter Circuit (Typical Wiring Shown)

ELECTRICAL SYSTEM



4

D

INSTRUMENTATION

mercruiser
STERN DRIVES & INBOARDS

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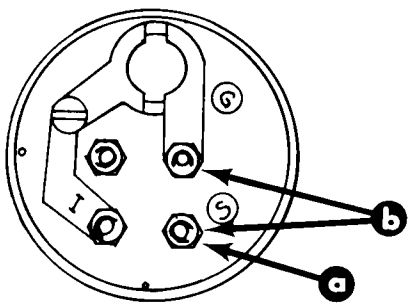
Gauges

Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

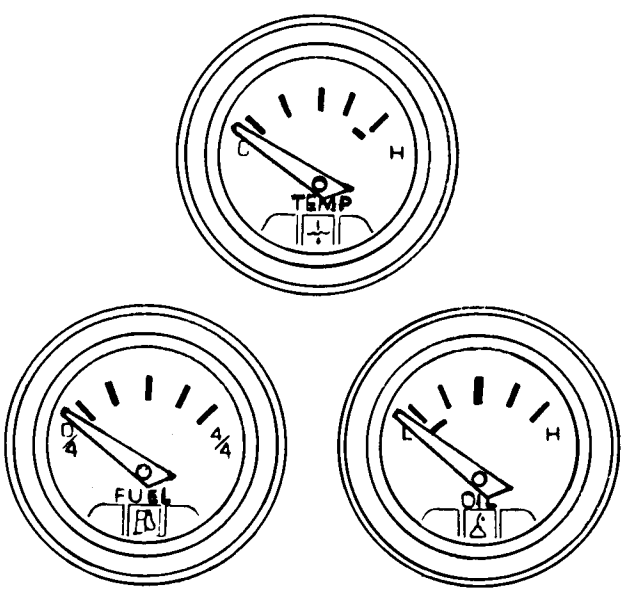
1. Turn ignition switch to "Off".
2. Remove wire from terminal "S".
3. Turn ignition switch to "Run". Gauges must be at "A" position.



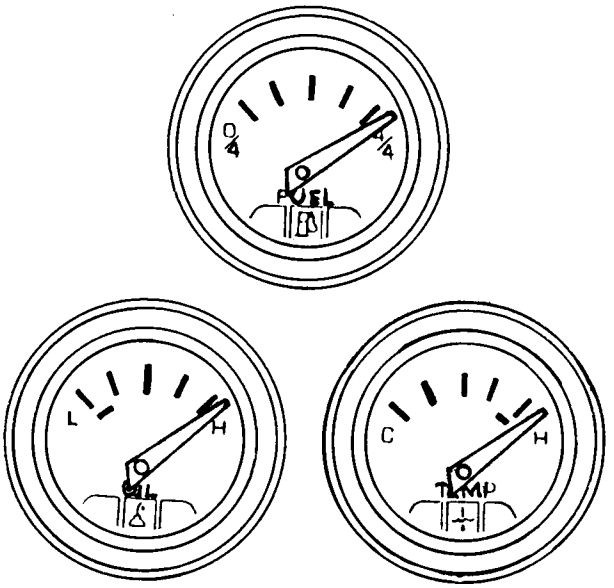
a - Remove Wire
b - Jumper Wire

Testing Gauge

4. Turn ignition switch "Off".
5. Connect jumper wire from terminal "G" to terminal "S".
6. Turn ignition switch to "Run". Indicator needle must read at "B" position.
7. Replace gauge if needle was not in positions as shown.



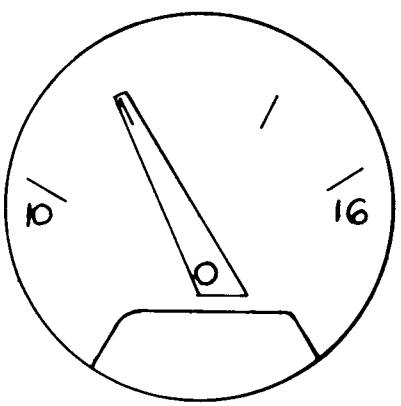
Position "A"



Battery Gauge

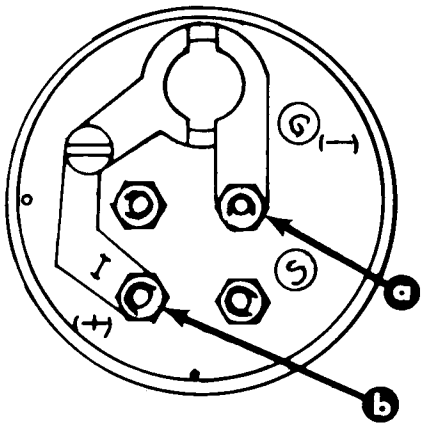
IMPORTANT: Fully charged battery must be used.

1. Turn ignition key to "Run" position.
2. Gauge reading should be approximately what battery voltage is. Shut key "Off".



Battery Gauge

3. If gauge is out of dash, connect jumper wires as shown in.

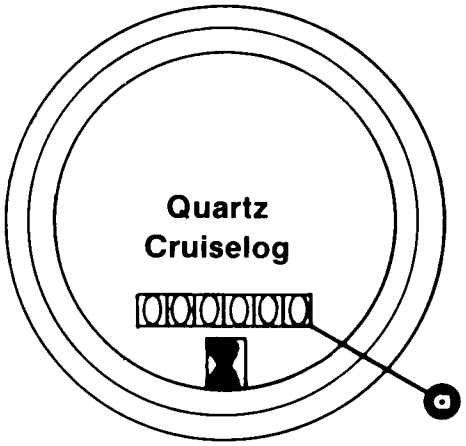


a - Jumper Wire - To Negative (-) Battery Terminal
b - Jumper Wire - To Positive (+) Battery Terminal

Jumper Wire Connections

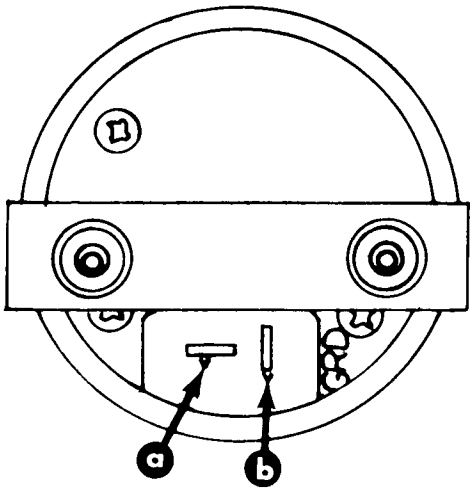
Cruiselog

1. Turn ignition key to "Run" position.
2. If gauge is good, run indicator will be turning. Turn key to "Off" position.
3. If gauge is out of dash, connect jumper wires as shown.



a - Run Indicator

Cruiselog



a - Jumper Wire - To Positive (+) Battery Terminal
b - Jumper Wire - To Negative (-) Battery Terminal

Vacuum Gauge

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

Speedometer

IMPORTANT: When testing speedometer gauge for accuracy, air pressure that is used for test must be regulated to specified PSI. DO NOT apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective.

Air Pressure Gauge PSI	Speedometer Gauge MPH
5.3	20 ± 1 (32 km/hr ± 1.6)
27.8	45 ± 1 (72 km/hr ± 1.6)

Tachometer

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

TACHOMETER TYPE	ALLOWABLE RANGE
6000 RPM	± 150 RPM
8000 RPM	± 200 RPM

Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. **Vacuum and speedometer:** Remove hose.
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: DO NOT distort case or bracket by overtightening.

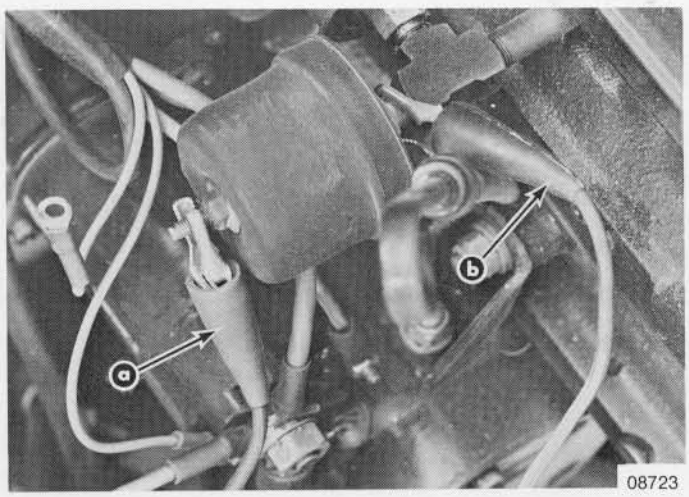
8. Connect ground (black) wire to ground terminal, if gauge is not mounted in metal panel.
9. Connect other wires to gauge as shown in "Section 3, Part F".
10. **Vacuum and Speedometer:** Connect hose.
11. Install gauge light socket.
12. Coat all terminals with Liquid Neoprene.
13. Reconnect battery cables to battery.

Senders

Oil Pressure

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to "Trouble-shooting" section.

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



a - Positive Lead
b - Negative Lead

Oil Pressure

Oil Pressure (Lbs./Sq. In.)	Ohms Reading	
	Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.3
40	91.7-113.6	45.9-56.8
80	9-49	11-24.5

DUAL STATION SENDER IDENTIFICATION

Sender will have 353-AM stamped on hex of sender.

Water Temperature

There is no accurate test that can be done without special equipment. Install new sender.

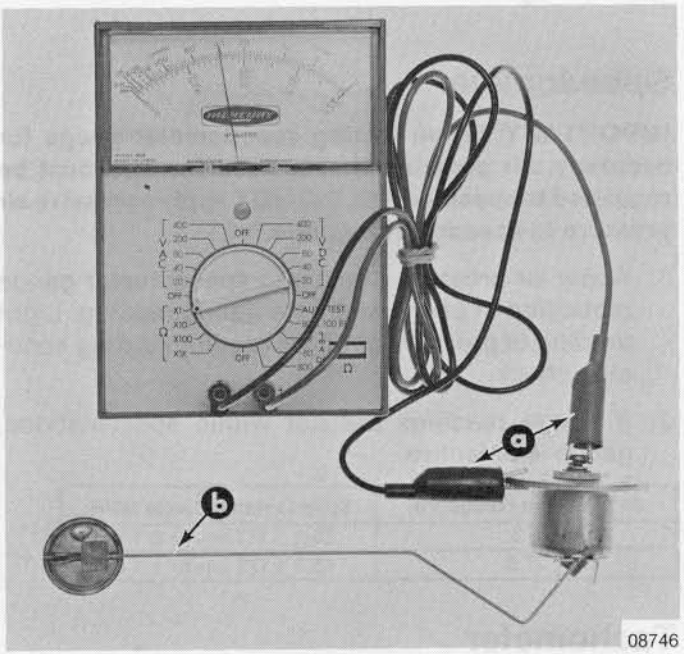
DUAL STATION SENDER IDENTIFICATION

Sender will have 362-BC stamped on hex of sender.

Fuel Tank Sender

FLANGE TYPE (FIGURES 2 and 3)

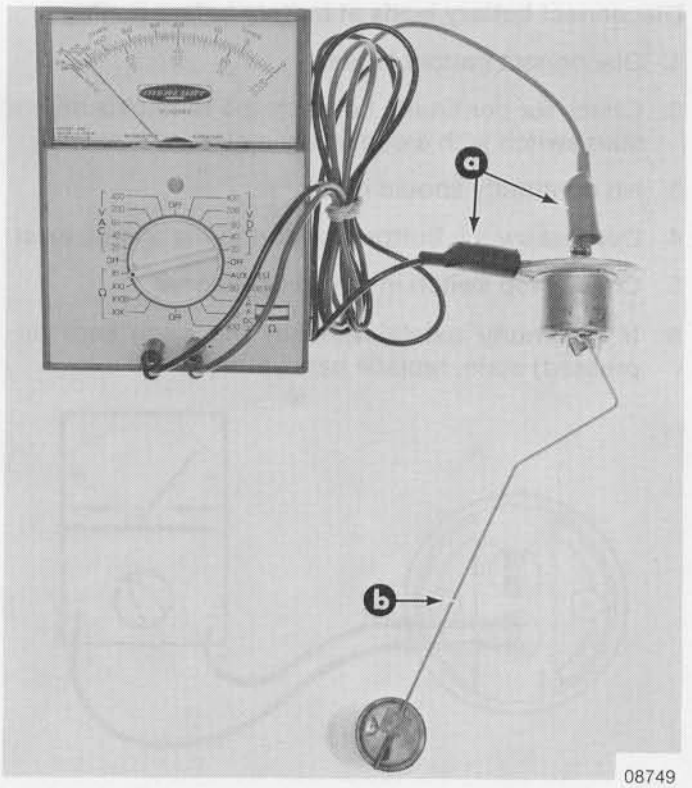
1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohmmeter between sending unit terminal and sending unit housing.
4. With float arm in "full" position (arm horizontal), ohmmeter should read 30 ohms (± 5 mm).



a - Ohmmeter Leads
b - Float Arm Horizontal

Arm Horizontal

5. With float arm in "empty" position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.

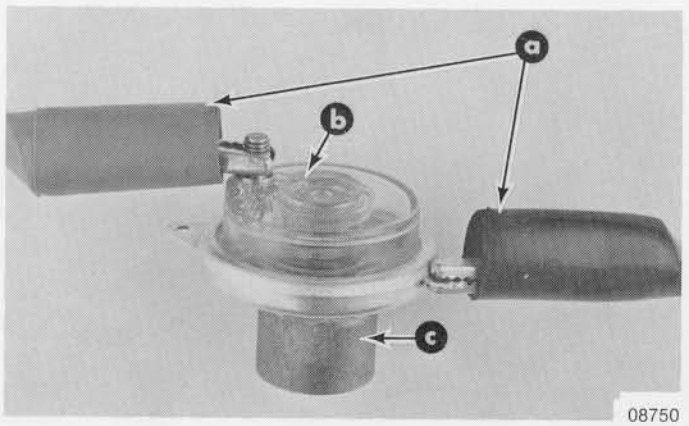


a - Ohmmeter Leads
b - Float Arm Vertical

Arm Vertical

CAPSULE TYPE

1. Disconnect wire from terminal on fuel tank capsule.
2. Remove 2 screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



a - Ohmmeter Leads
b - Capsule
c - Magnet

Ohmmeter and Magnet

5. Turn magnet counterclockwise until fuel capsule indicator reads empty. Ohmmeter should read 240 ohms (± 5 ohms).
6. Turn magnet clockwise until fuel capsule indicator reads "Full". Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.

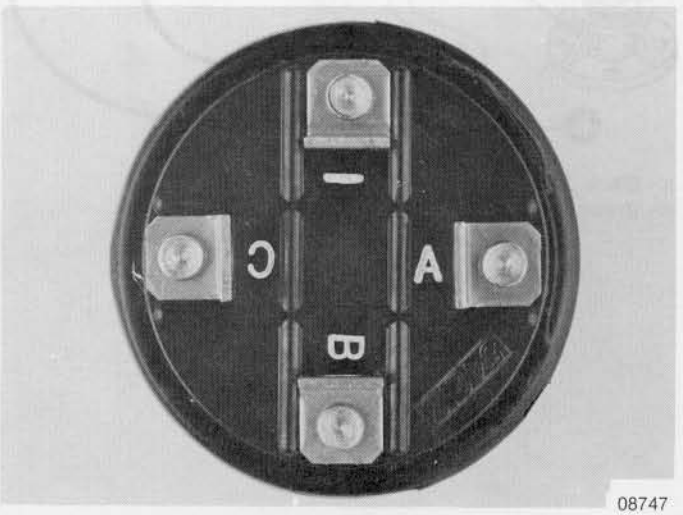
Switches

Ignition Key Switch

⚠WARNING

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
2. With key switch in "Off", there should be no continuity between switch terminals.
3. With key switch in "Run", continuity will exist between switch terminal "B" to "A" and "B" to "I". There should be no continuity between terminal "C" and any other terminals.
4. With key switch in "Start", continuity will exist between terminal "B" to "A", "B"to "I" and "B" to "C".
5. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-thru-5, preceding. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.

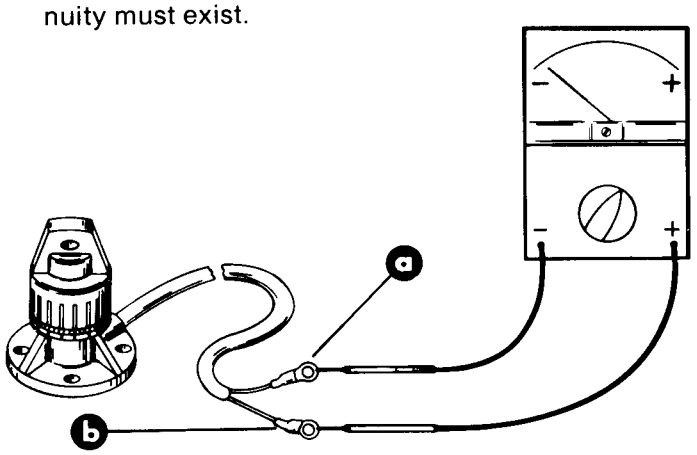


Switch Terminal Identification

Emergency Stop Switch

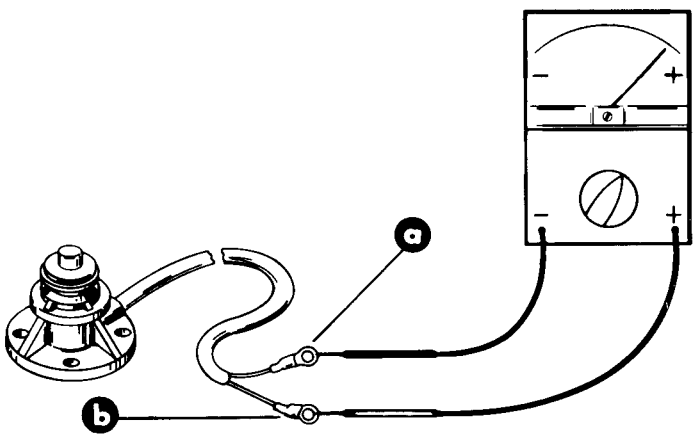
IMPORTANT: White lead must be taped back to switch harness.

1. Remove both leads from connections.
2. Using a test meter, check (with the switch cap on) for continuity between black and green, no continuity must exist.



a - Black
b - Green

3. With cap off, continuity must exist between black and green.



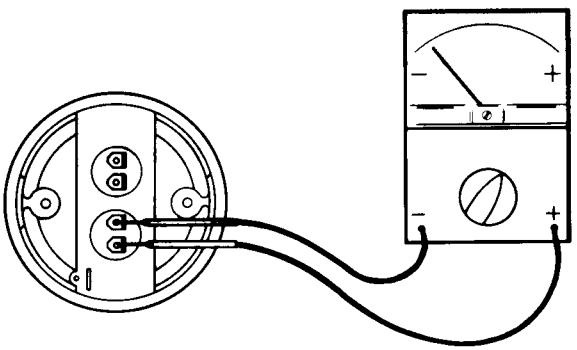
a - Black
b - Green

Start/Stop Panel

⚠WARNING

Disconnect battery leads at battery before testing.

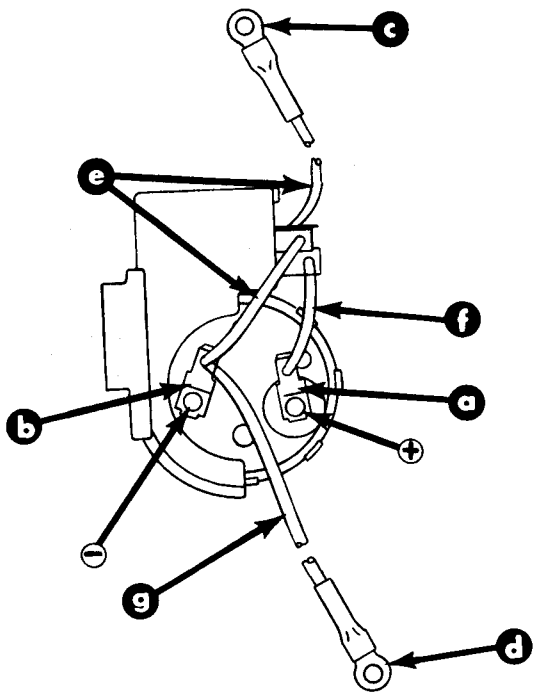
1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.
3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the open (not depressed) state, replace panel button.



Audio Warning System

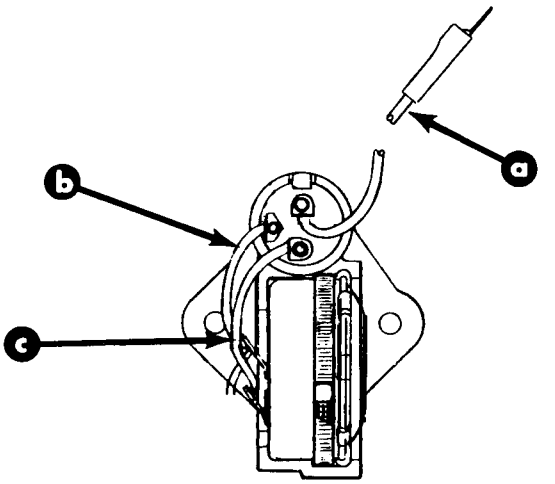
Horn and Timer

1. Turn key to "Run" position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
4. If horn worked in Step 3:
   a. Connect jumper wires as shown.
   b. Repeat Step 2.
   c. If horn sounds, problem is in tan/blue wire back to engine or switches on engine.



a - Jumper Wire to 12-V (+) — STEP 3
b - Jumper Wire to Ground (−) — STEP 3
c - Jumper Wire to 12-V (+) — STEP 4
d - Jumper Wire to Ground (−) — STEP 4
e - Purple Wire
f - Red Wire
g - Tan/Blue Wire

Testing Horn and Timer



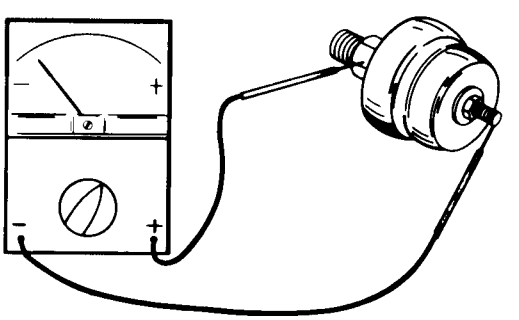
a - Purple Wire
b - Purple Jumper Wire
c - Red Jumper Wire

Timer Wiring

Oil Pressure Switch

Refer to "Section 3, Part E" for switch locations. Switch is normally closed.

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex.
3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI (41 kPa), meter should indicate NO continuity.



SWITCH IDENTIFICATION

Switch has 364-AF stamped on hex of sender.

Water Temperature Switch

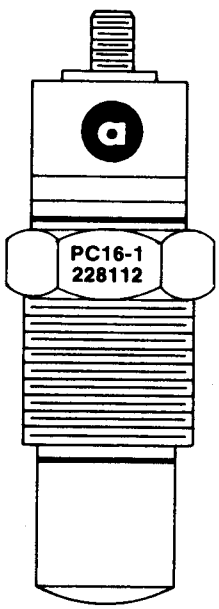
Refer to "Section 3, Part E" for switch locations. Switch is normally open.

48952 SWITCH	
Opens	150° F - 170° F (66° C - 77° C)
Closes	190° F - 200° F (88° C - 93° C)

Model	Seawater Cooled Engine	Closed Cooled Engine
All Models	(Note 1)	(Note 1)

NOTES:
1. Uses 48952 switch

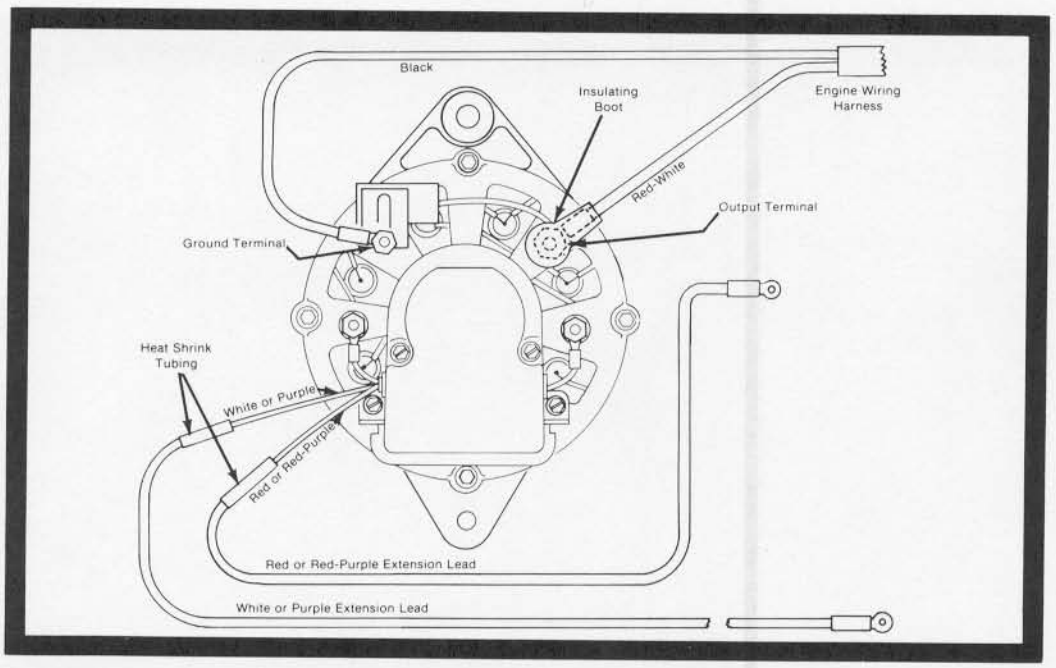
SWITCH IDENTIFICATION



a - 48952 Switch with Red Mylar Sleeve

Water Temperature Switches

ELECTRICAL SYSTEM



4

E

ELECTRICAL KITS

mercruiser
STERN DRIVES & INBOARDS

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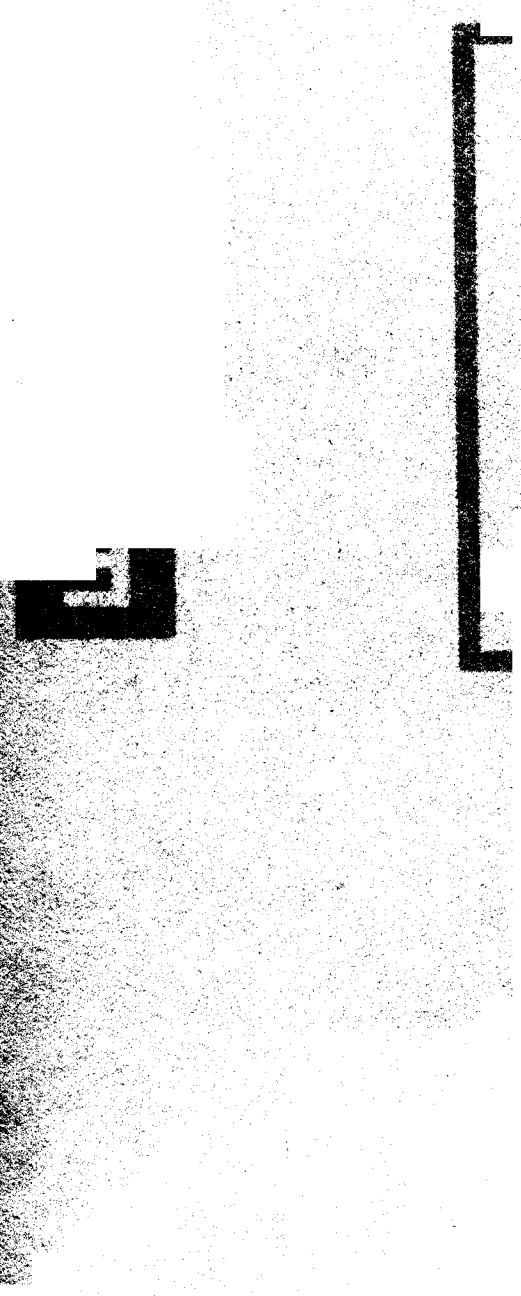
MCM 120/140 Wiring Harness Kit 84-86673A2	4E-5



Audio Warning System Kit 86047A3

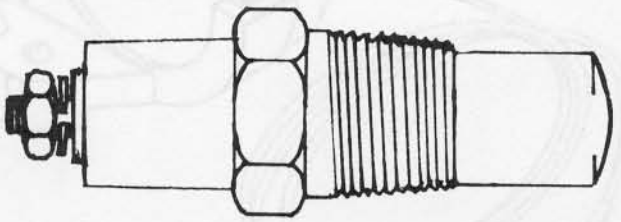
Installing Water Heat Switch

INSTALLING WATER HEAT SWITCH on IN-LINE ENGINES with STANDARD and CLOSED COOLING

NOTE: On standard cooled engines, temperature switch is designed for thermostat housing 47587A2. If thermostat housing 63908A2 is on engine, 1/8-27NPTF tapped hole must be drilled and tapped to 3/8-18NPTF. Remove housing to make modification, then blow out with compressed air to remove metal chips and reinstall housing with a new gasket.

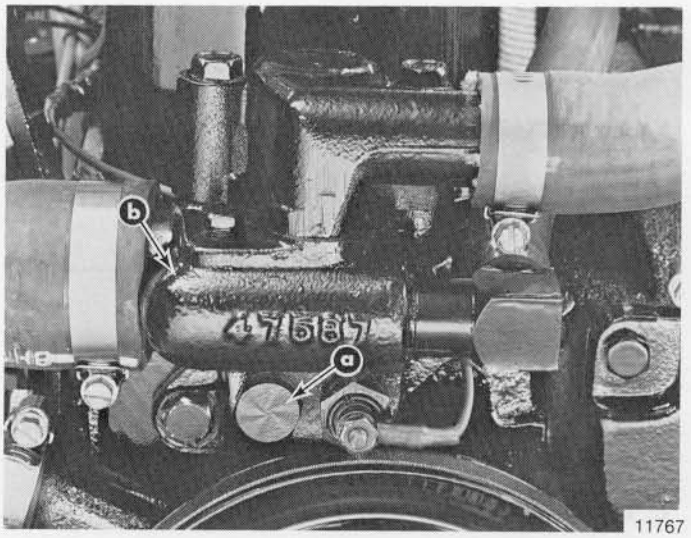
NOTE: On closed cooled engines, reducing bushing 22-52382 (not in kit) must be installed into thermostat housing before heat switch.

1. Drain cooling system.



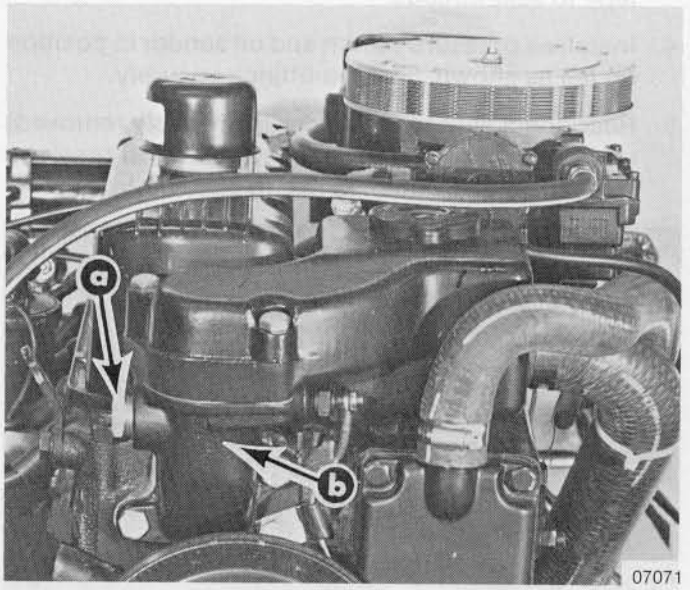
Water Heat Switch

2. Remove plug from thermostat housing at location shown.



a - Plug
b - Thermostat Housing

In-Line Standard Cooling

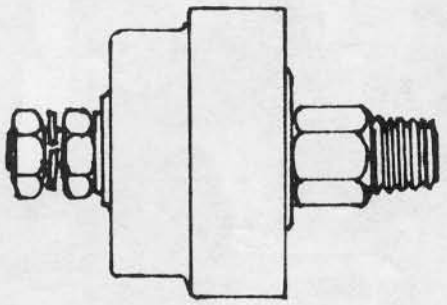


a - Plug
b - Thermostat Housing

In-Line Closed Cooling

3. Install water heat switch from kit into thermostat housing. Use teflon tape to seal threads and tighten securely.
4. Attach 3 ft. (914mm) tan/light blue wire (from kit) to heat switch with nut and lockwasher.
5. Route tan/light blue wire toward starboard side, then back to oil sender (to be removed later). Secure wire to wire harness (located on starboard side of engine), being sure that wire will not come in contact with hot spots or moving parts.

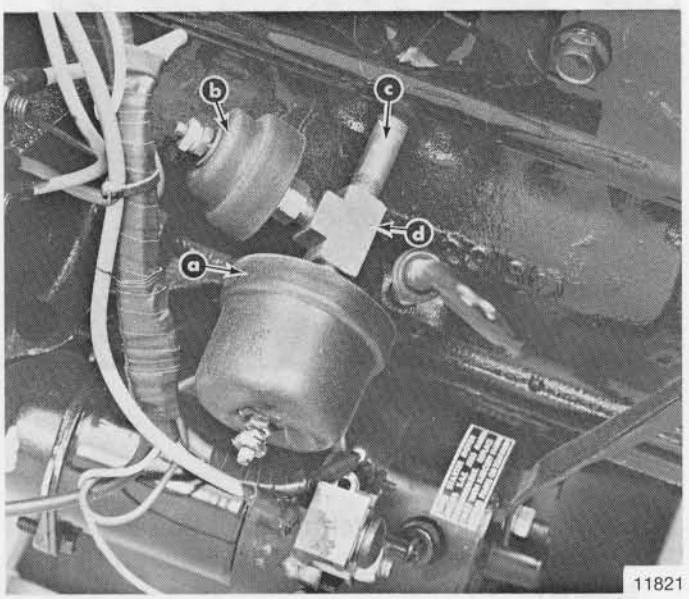
Installing Oil Pressure Switch



Oil Pressure Switch

INSTALLING OIL PRESSURE SWITCH on IN-LINE ENGINES

1. Disconnect both battery leads at battery.
2. Disconnect wire from oil sender and remove sender (also nipple and elbow, if so equipped).
3. Install nipple, then tee fitting (from kit), using teflon tape to seal threads.
4. Install oil pressure switch and oil sender in position on tee as shown. Tighten fittings securely.
5. Reconnect wire to oil sender (previously removed) and connect wire from heat switch to oil pressure switch. Torque nut to 15 lbs. in (1.7 N.m).

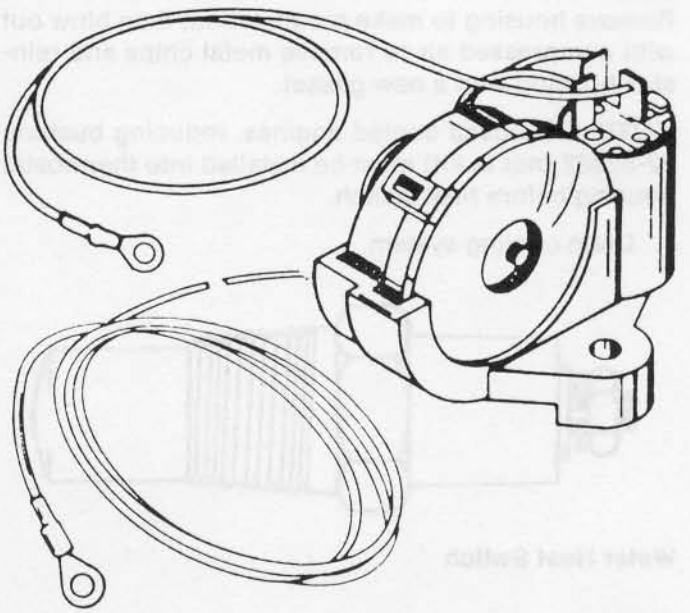


a - Oil Sender
b - Oil Pressure Switch
c - Nipple
d - Tee Fitting

Oil Pressure Switch Installed

Installing Warning Buzzer

1. Disconnect battery leads, if not already disconnected.
2. Mount buzzer under dashboard with 2 screws (from kit) in location that is not in obvious sight but is easily accessible for installation and maintenance. Location should not restrict buzzer sound and also should be within limits of 18" (460mm) purple lead. (Lead will be connected to instrument terminal in dashboard.)



Warning Buzzer

⚠WARNING

Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.

3. Attach purple lead to "+ 12V" switched terminal of any adjacent gauge [purple to purple (BIA) or purple to white (earlier MerCruiser)]. The attaching terminal should be "off" when ignition switch is in "Off" position.
4. Route tan/light blue wire from buzzer back to engine compartment, supporting wire every 18". Be sure that wire does not chafe or get pinched and does not come in contact with bilge water or moving parts.
5. Connect tan/light blue lead from buzzer to engine water heat switch or oil pressure switch, whichever is more accessible with lockwasher and nut. Torque nut to 15 lbs. in. (1.7 N.m) (DO NOT over-tighten).
6. Place decal on bottom of glass face of water temperature gauge and of oil pressure gauge, if equipped.

ALARM INDICATES LOW OIL OR OVERHEATING

Decal (To Be Placed on Face of Gauge)

7. Place decal in convenient location on dashboard.

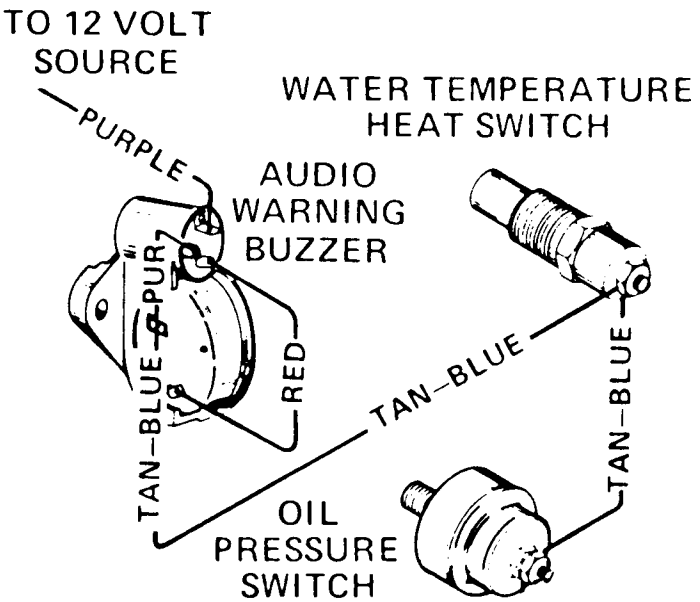
ENGINE SENSOR HORN WILL SOUND WHEN OIL PRESSURE IS TOO LOW OR TEMP. IS TOO HOT.

TO TEST HORN

1. TURN KEY TO ON POSITION (ENGINE OFF)
2. WAIT 7 TO 14 SEC. FOR HORN TO SOUND

Decal (To Be Placed on Dashboard)

8. Reconnect battery leads.
9. Fill Closed Cooling System (on engines so equipped) with water/anti-freeze solution.
10. Test switch (horn) as explained on decal.
11. Seal all electrical connections with Liquid Neoprene.



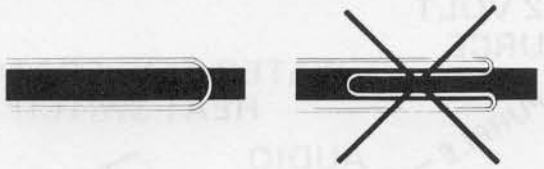
Audio Warning System Wiring Diagram

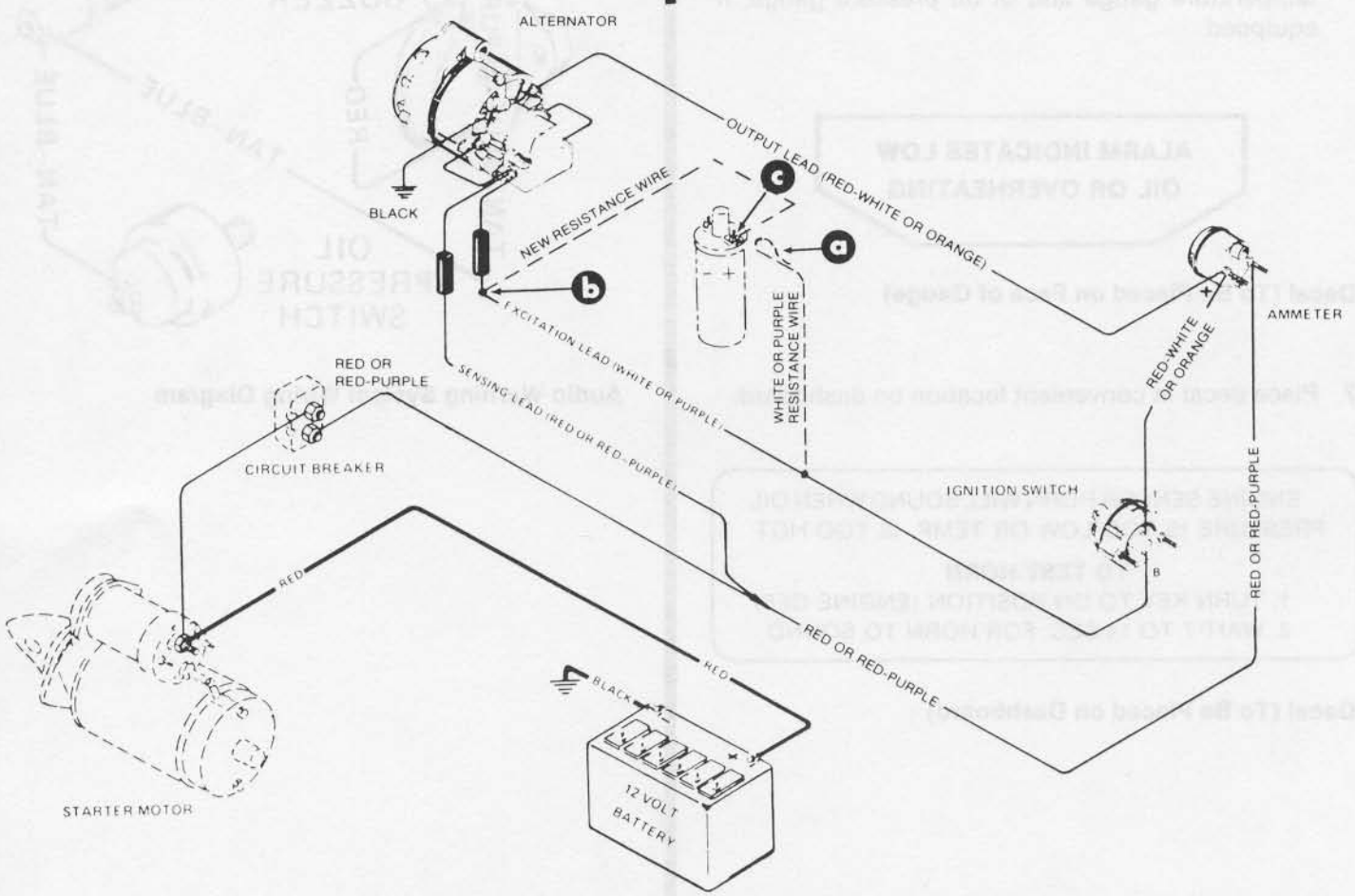
Resistance Wire Replacement Kit 84-94227A2

Installation Instructions

⚠WARNING

DO NOT tape more than two (2) layers of resistance wire in any one section of engine harness.





a - Disconnect Damaged White or Purple (Stainless Steel Core) Resistance Wire From Ignition Coil and Tape Back to Harness

b - Strip Outer Insulating Jacket of White or Purple (Copper Core) Wire. Wrap and Solder Copper End of NEW Resistance Wire to White or Purple Wire Insulate Junction.

c - Attach Ring Terminal End of NEW Resistance Wire to Ignition Coil and Coat Connection with Quicksilver Liquid Neoprene

Alternator System With Electric Choke (Typical)

Emergency Stop Switch 65503A2

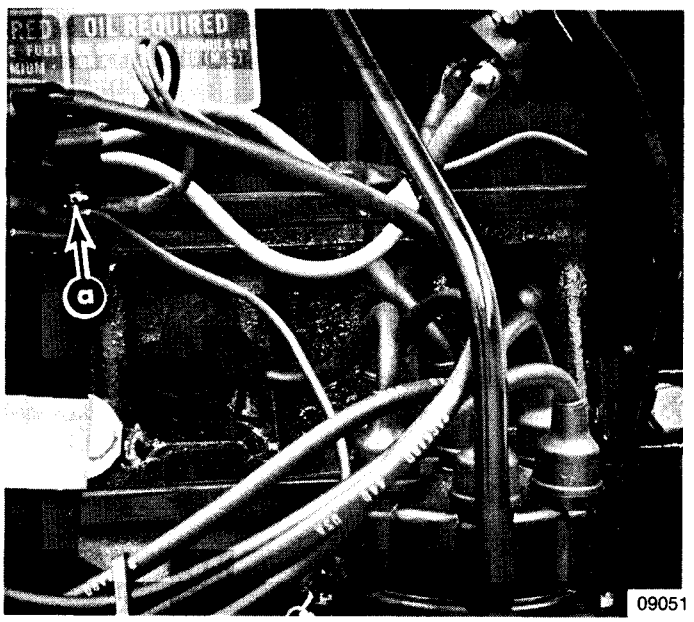
⚠WARNING
Disconnect battery leads at battery BEFORE attempting to install ignition safety stop switch.

⚠CAUTION
This stop switch is to be used as a safety stop switch only. It should not be used as the normal engine shut-off.

IMPORTANT: Emergency stop switch is supplied with a second cap to be used as a spare (to enable engine to be started, in case first cap is lost). Keep spare cap in a handy place aboard boat.

MerCruiser Engines with Breaker Point Ignition

1. Tape white stop switch harness lead to harness and insulate with at least two layers of electrical tape.
2. Connect black stop switch harness lead to ignition coil negative (-) terminal along with existing wires.



a - Negative (-) Coil Terminal

Wire Location (Typical 4 Cylinder MerCruiser Engines with Breaker Point Ignition)

3. Connect green stop switch harness lead to convenient engine ground.
4. Check stop switch operation after installation is completed.
5. Coat all electrical connections with Liquid Neoprene (92-25711) after checking switch operation.
6. Attach stop switch cap to operator's person with a suitable cord (lanyard). Length of cord should be no longer than absolutely necessary and should have a minimum breaking strength of 100 lbs. (45kg).

IMPORTANT: To prevent the possibility of damage to ignition components, turn ignition switch to "Off" position as soon as possible after safety stop switch has been activated.

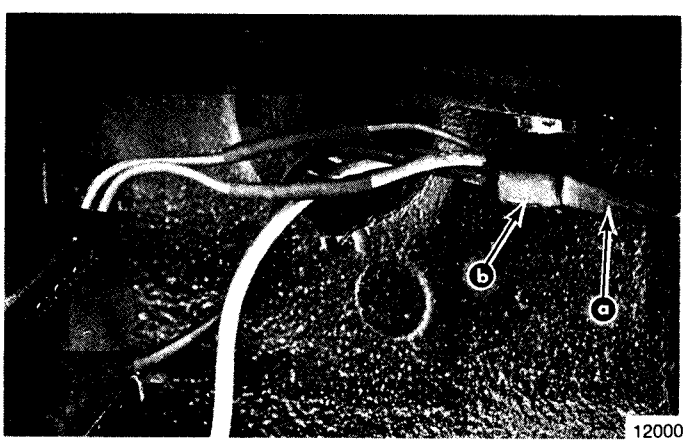
7. To reset stop switch after activation, simply install stop switch cap with a straight firm push.

Wiring Harness Kit 84-86673A2

⚠WARNING
Disconnect both battery cables from battery to prevent accidental shorting of wires when removing and installing wiring harness.

NOTE: The fasteners, which are provided with this wiring harness, MUST BE used, as explained in the following instructions, when the harness is installed on MCM 120 Engines below Serial No. 5263237 and MCM 140 Engines below Serial No. 5279046. Engines with serial numbers above those listed already have the fasteners installed.

1. Remove (and discard) old wiring harness. Retain harness mounting plate and 4 attaching screws and all terminal fasteners.
2. Install wiring harness receptacle in wiring harness bracket and secure with mounting plate and 4 screws (retained in Step 1).
3. Route wiring harness and install fastners provided with harness, as follows:
   a. Route section of harness (containing orange wire) to port side of engine. Install small J-clamp with 9/32" (7mm) attaching holes to bottom side of exhaust manifold with screw, as shown, and tighten securely. Route harness thru clamp and bend clamp shut.

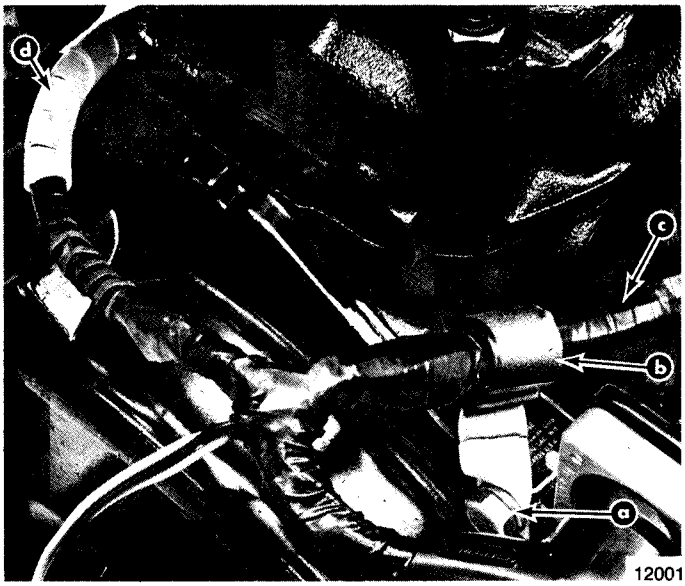


a - Wiring Harness
b - J-Clamp (9/32" Attaching Hole)

Wiring Harness Fastened to Exhaust Manifold

IMPORTANT: Be sure that wiring harness is positioned so that the harness protector is located between the flywheel housing and bottom edge of manifold.

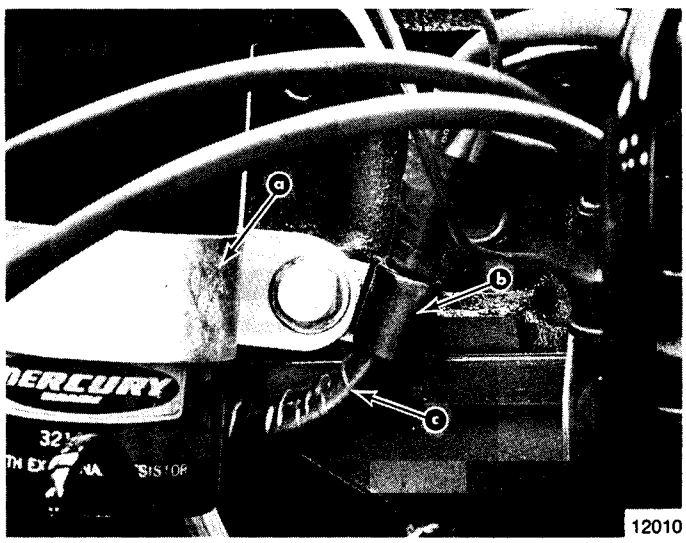
b. Remove screw from flywheel housing (at the serial number plate) and install large J-clamp with 13/32" (10mm) attaching hole, as shown. Torque screw to 21 lbs. ft. (28 N.m). Route harness thru clamp and bend clamp shut.



a - Flywheel Housing Attaching Screw
b - J-Clamp (13/32" Attaching Hole)
c - Wiring Harness
d - Harness Protector

Wiring Harness Fastened to Flywheel Housing

c. Remove screw from ignition coil mounting bracket and install medium J-clamp with 11/32" (9mm) attaching hole, as shown. Tighten screw securely. Route end of harness thru clamp and bend clamp shut. Position harness leads so that wires do not contact fuel line.



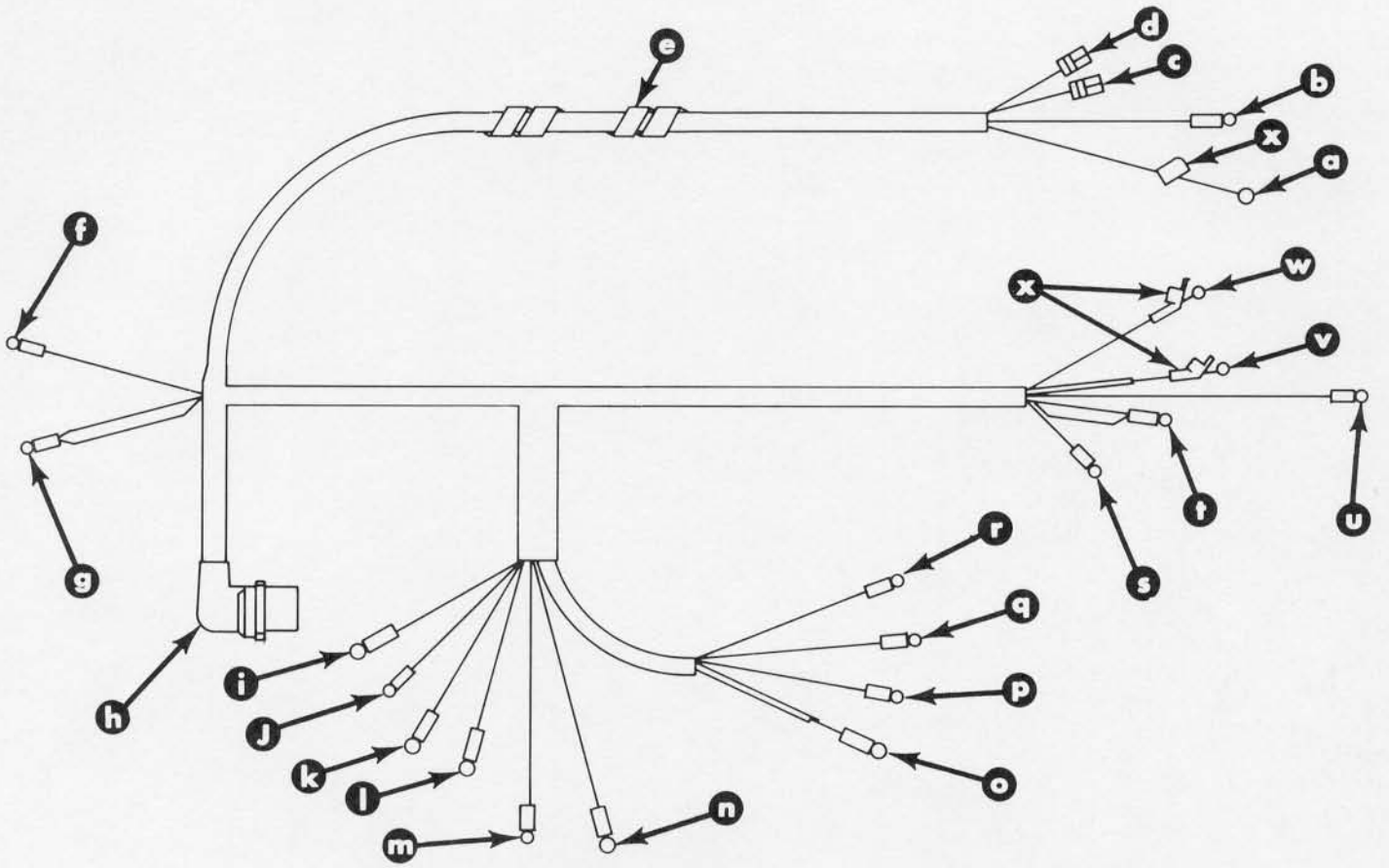
a - Ignition Coil Mounting Bracket
b - J-Clamp (11/32" Attaching Hole)
c - Wiring Harness

Wiring Harness Fastened to Ignition Coil Mounting Bracket

4. If engine is equipped with a fuse on starter solenoid, remove (and discard) fuse.
5. Connect wiring harness leads to electrical components, as shown, being sure to complete the following:
   a. Position insulator boots over terminals on wires so equipped.
   b. Apply a coat of Liquid Neoprene to all terminal connections which are not protected by an insulator boot.
   c. Place heat shrink tubing (supplied with kit) over end of leads coming from alternator. Connect purple engine harness lead to purple (or white) alternator lead. Connect red-purple engine harness lead to red-purple (or red) alternator lead. Position heat shrink tubing over connections and heat with heat gun until secure.
   d. MCM engines, that are equipped with Delco single-wire alternators, do not use the purple and red-purple alternator leads (items "c" and "d"). On these engines, the purple and red-purple leads MUST BE insulated and taped back to wiring harness, as follows:
      1) Fold terminal on end of purple lead back against purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminal.
      2) Fold terminal on end of red-purple lead back against red-purple lead and secure with electrical tape. Insulate with at least 4 layers of electrical tape completely covering the exposed metal of the terminals.
      3) Fold insulated purple and red-purple leads back against harness and secure with electrical tape.

⚠CAUTION
Failure to adequately insulate the purple and red-purple leads, as explained above, can result in electrical failure.

6. After making all necessary harness connections, reconnect positive (+) battery cable to positive battery terminal and negative (-) battery cable to negative battery terminal.

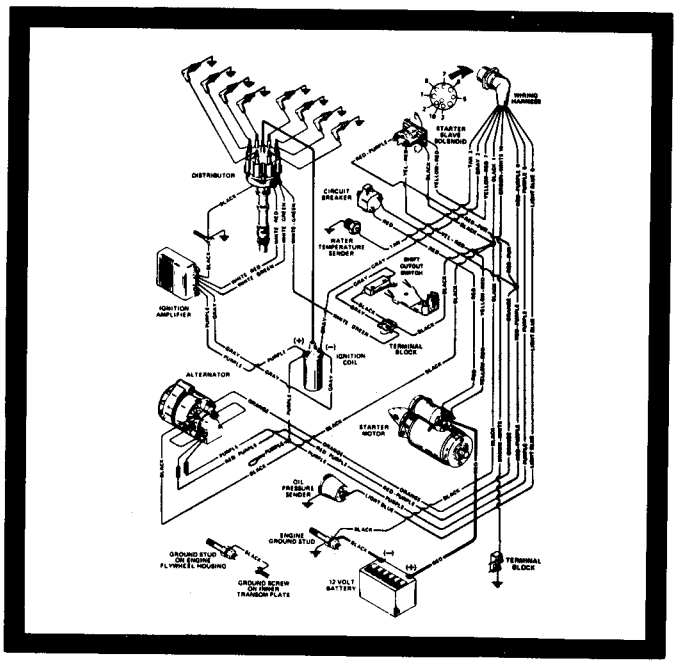


a - Orange Wire - Connect to Alternator Output ("BAT") Terminal
b - Black Wire - Connect to Alternator Ground Terminal
*c - Purple Wire - Connect to Alternator Purple (or White) Wire
*d - Red-Purple Wire - Connect to Alternator Red-Purple (or Red) Wire
e - Harness Protector
f - Black Wire - Connect to Shift Interrupter Switch Terminal Block Mounting Screw
g - Gray Wire - Connect to Insulated Terminal on Shift Interrupter Switch Terminal Block
h - Receptacle
i - Black Wire - Connect to Flywheel Housing Attaching Screw on Starboard Side of Engine
j - Black Wire - Connect to Small Lower Terminal on Slave Soleniod
k - Red-Purple Wire - Connect to One Large Terminal on Slave Solenoid
l - Yellow-Red Wire - Connect to Other Large Terminal on Slave Solenoid
m - Yellow-Red Wire - Connect to Small Upper Terminal on Slave Solenoid
n - Brown-White Wire - Connect to Insulated Terminal on Trim Position Sender Terminal Block
o - Red Wire - Connect to Large Terminal on Starter Mounted Solenoid
p - Yellow-Red Wire - Connect to "S" Terminal on Starter Mounted Solenoid
q - Purple-Yellow Wire - Connect to 'R" Terminal on Starter Mounted Solenoid
r - Light Blue Wire - Connect to Oil Pressure Sender on Side of Engine Block
s - Gray Wire - Connect to Negative (-) Terminal on Ignition Coil
t - Purple and Purple-Yellow Wires - Connect to Positive (+) Terminal on Ignition Coil
u - Tan Wire - Connect to Water Temperature Sender on Front of Thermostat Housing
v - Red Wire - Connect to Upper Terminal on Circuit Breaker
w - Red-Purple Wire - Connect to Lower Terminal on Circuit Breaker
x - Insulator Boot

*Install and shrink sleeve (supplied with harness) over these quick disconnect terminals. Be sure that all exposed metal on the terminals is covered.

Wiring Harness (84-86673A2) Electrical Connections

ELECTRICAL SYSTEM



4

F

WIRING DIAGRAMS

mercruiser
STERN DRIVES & INBOARDS

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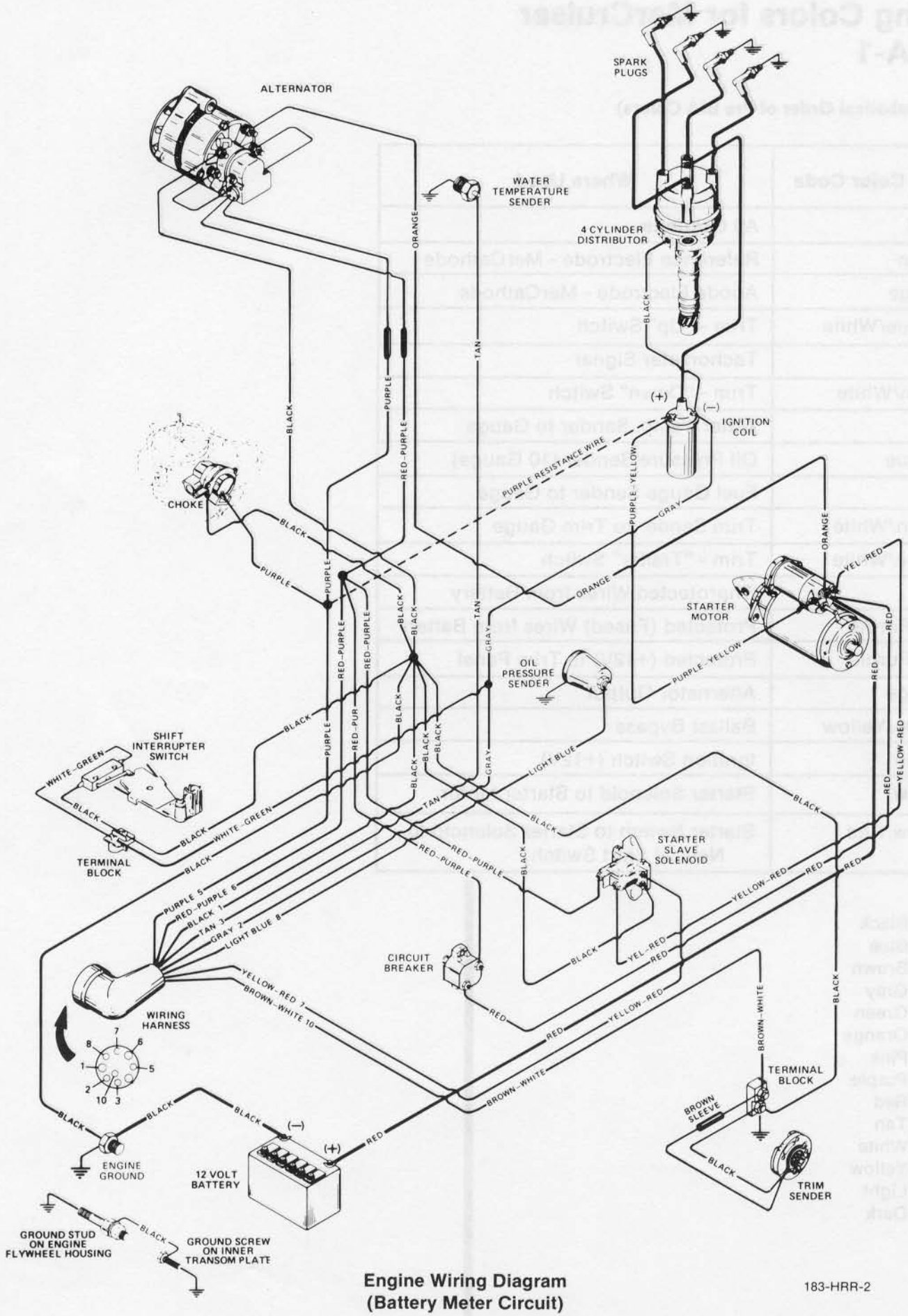
Wiring Colors for MerCruiser MR/A-1

(In Alphabetical Order of Pre BIA Colors)

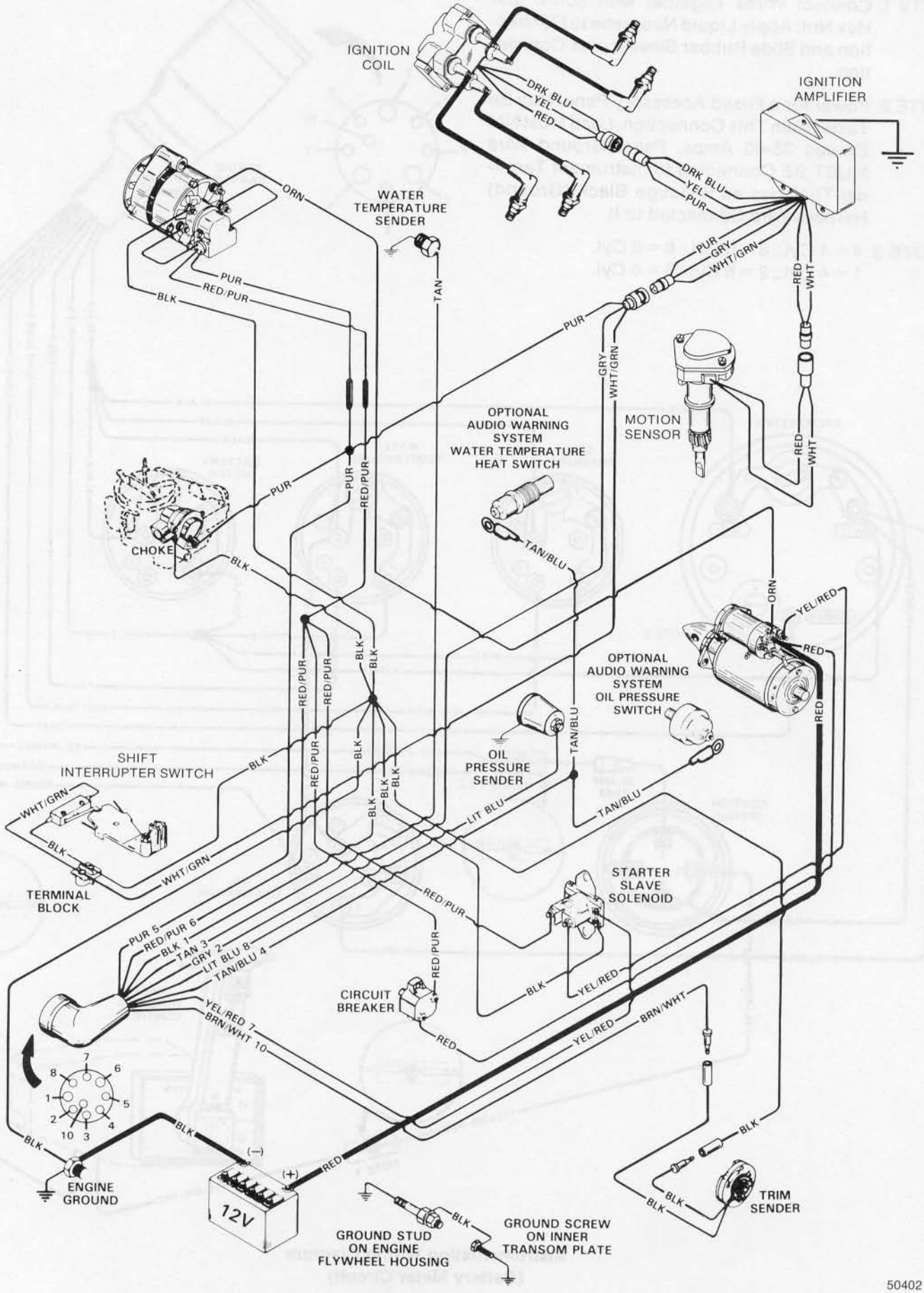
BIA Color Code	Where Used
Black	All Grounds
Brown	Reference Electrode - MerCathode
Orange	Anode Electrode - MerCathode
Lt. Blue/White	Trim - "Up" Switch
Gray	Tachometer Signal
Green/White	Trim - "Down" Switch
Tan	Water Temp. Sender to Gauge
Lt. Blue	Oil Pressure Sender (10 Gauge)
Pink	Fuel Gauge Sender to Gauge
Brown/White	Trim Sender to Trim Gauge
Purple/White	Trim - "Trailer" Switch
Red	Unprotected Wires from Battery
Red/Purple	Protected (Fused) Wires from Battery
Red/Purple	Protected (+12V) to Trim Panel
Orange	Alternator Output
Purple/Yellow	Ballast Bypass
Purple	Ignition Switch (+12V)
Yellow	Starter Solenoid to Starter Motor
Yellow/Red	Starter Switch to Starter Solenoid to Neutral Start Switch

BLK • Black
BLU • Blue
BRN • Brown
GRY • Gray
GRN • Green
ORN • Orange
PNK • Pink
PUR • Purple
RED • Red
TAN • Tan
WHT • White
YEL • Yellow
LIT • Light
DRK • Dark



Engine Wiring Diagram
(Battery Meter Circuit)

183-HRR-2



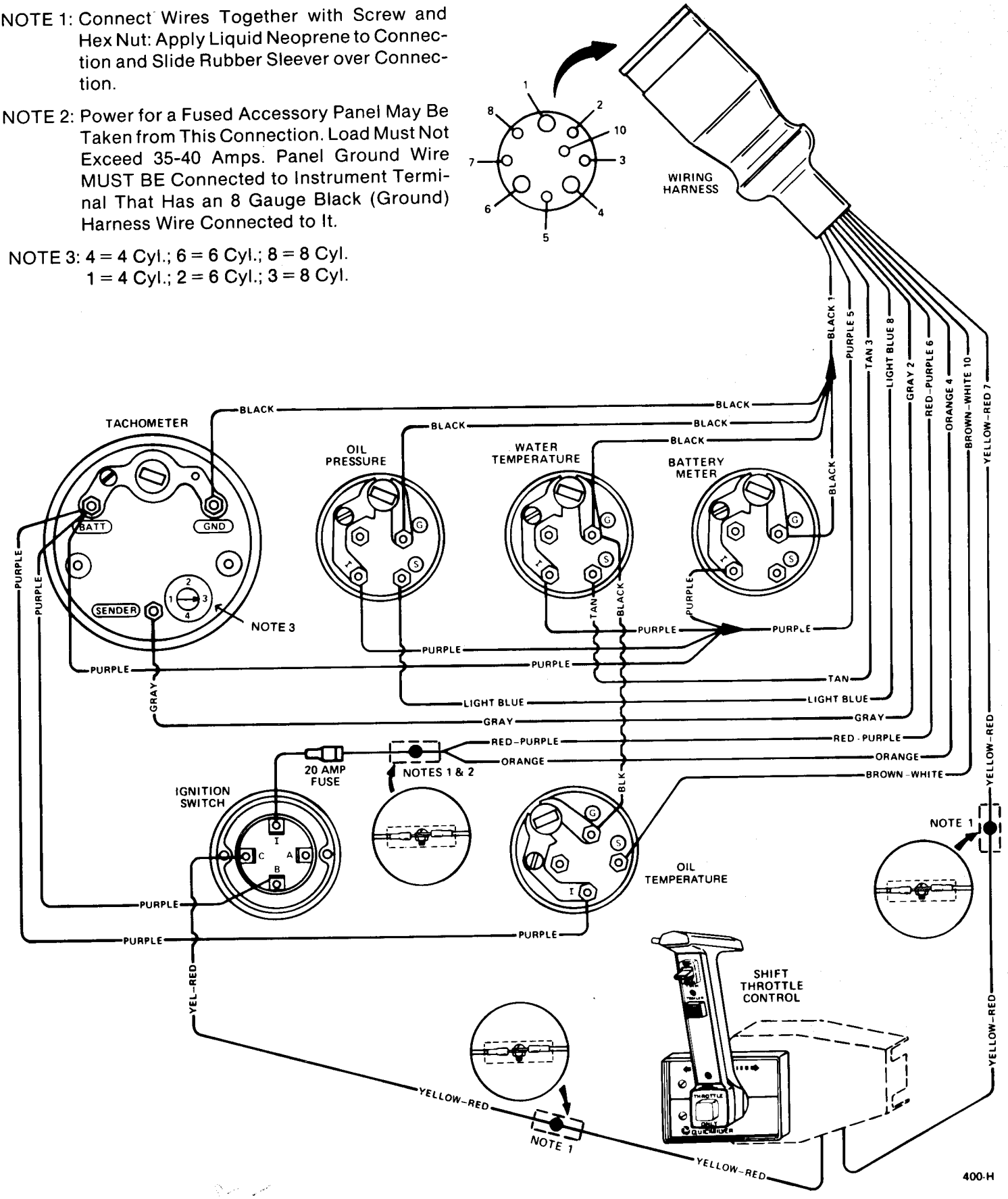
50402

ENGINE WIRING DIAGRAM
DIGITAL DISTRIBUTORLESS IGNITION SYSTEM (DDIS)

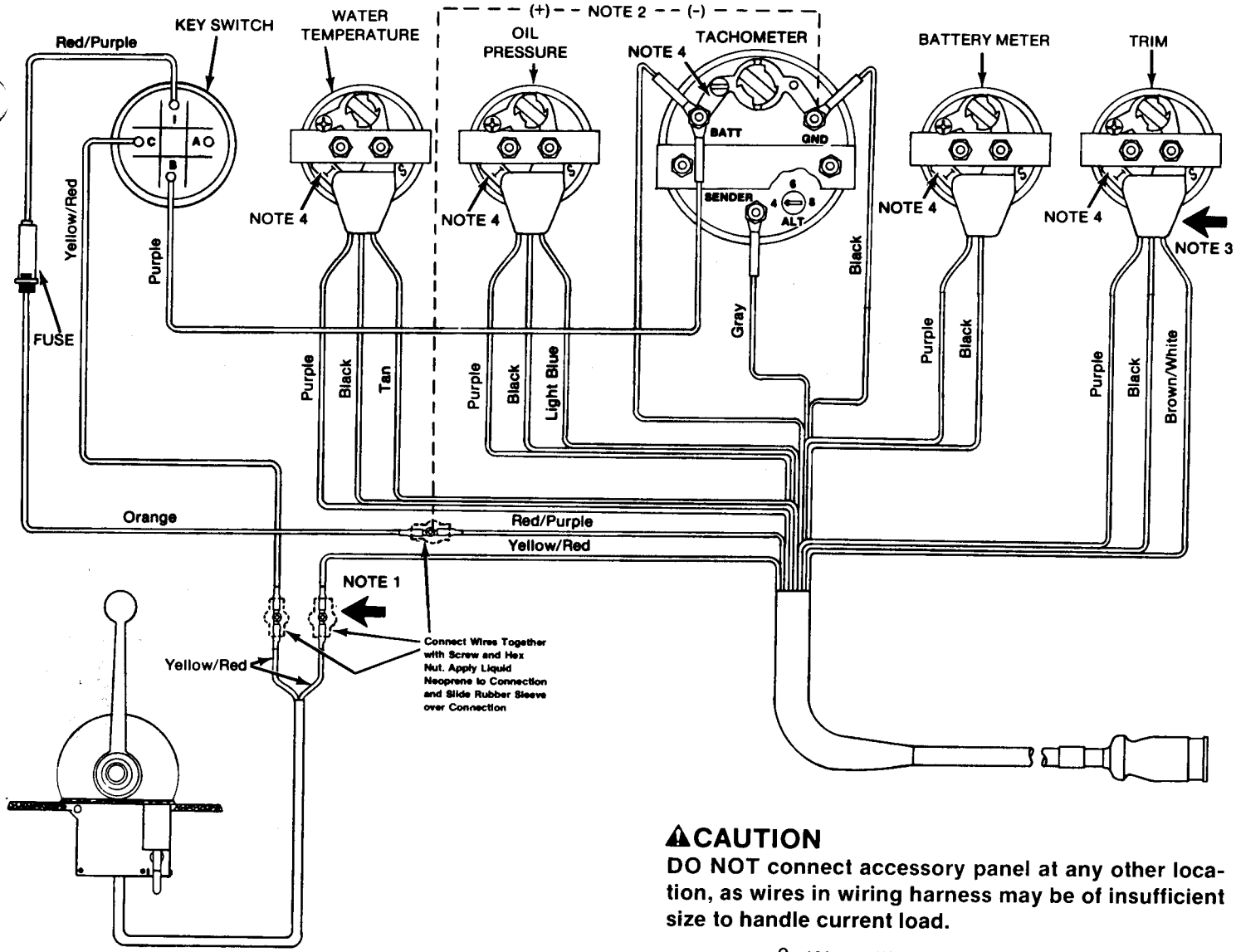
NOTE 1: Connect Wires Together with Screw and Hex Nut: Apply Liquid Neoprene to Connection and Slide Rubber Sleever over Connection.

NOTE 2: Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 35-40 Amps. Panel Ground Wire MUST BE Connected to Instrument Terminal That Has an 8 Gauge Black (Ground) Harness Wire Connected to It.

NOTE 3: 4 = 4 Cyl.; 6 = 6 Cyl.; 8 = 8 Cyl.
1 = 4 Cyl.; 2 = 6 Cyl.; 3 = 8 Cyl.



Instrumentation Wiring Diagram
(Battery Meter Circuit)



IMPORTANT: Be sure that connector plugs (when connecting harness) are installed on terminals before mounting brackets are installed on instruments.

NOTES: 1. If a neutral safety switch is incorporated in the remote control connect yellow/red wires as shown. If engine is equipped with a neutral safety switch on the engine, connect yellow/red ignition switch wire directly to yellow/red wiring harness wire with screw, nut and sleeve.

⚠CAUTION

Neutral start safety switch MUST BE USED in cranking circuit. If remote control does not incorporate this switch, it must be part of engine wiring.

2. An accessory fuse panel may be connected at this point. Load may not exceed 35 amps.

⚠CAUTION

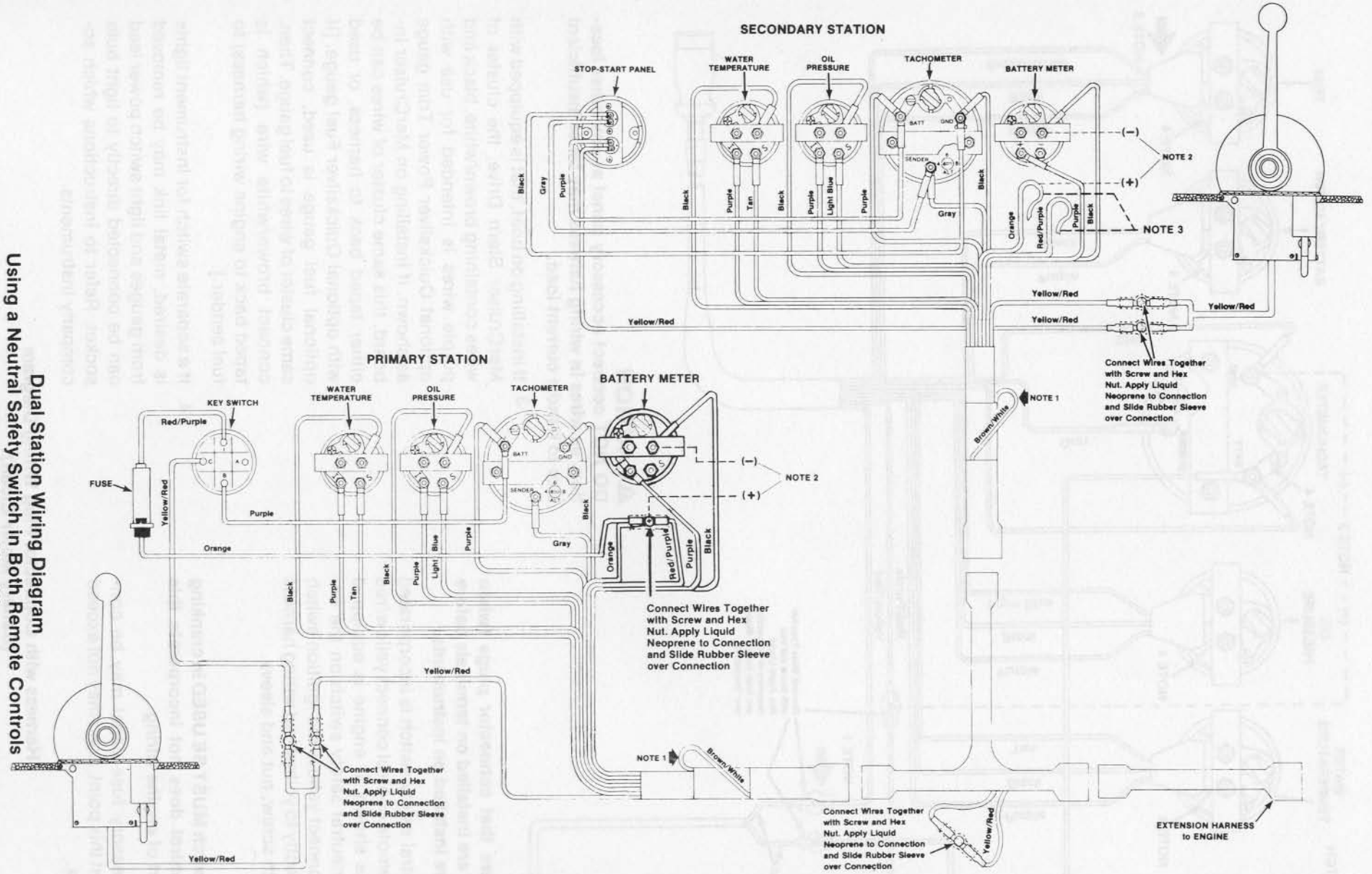
DO NOT connect accessory panel at any other location, as wires in wiring harness may be of insufficient size to handle current load.

3. If installing on boat, that is equipped with MerCruiser Stern Drive, the cluster of wires containing brown/white, black and purple wires is intended for use with optional Quicksilver Power Trim gauge as shown. If installing on MerCruiser Inboard, this same cluster of wires can be either taped back to harness, or used with optional Quicksilver Fuel gauge. [If optional fuel gauge is used, connect same cluster of wires to fuel gauge. Then, connect brown/white wire (which is taped back to engine wiring harness) to fuel sender.]

4. If a separate switch for instrument lights is desired, metal link may be removed from gauges and light switch power lead can be connected directly to light bulb socket. Refer to instructions which accompany instruments.

Harness with Connector Plug Wiring Diagram (Battery Meter Cicuit)

Dual Station Wiring Diagram
Using a Neutral Safety Switch in Both Remote Controls
(Battery Meter Circuit)

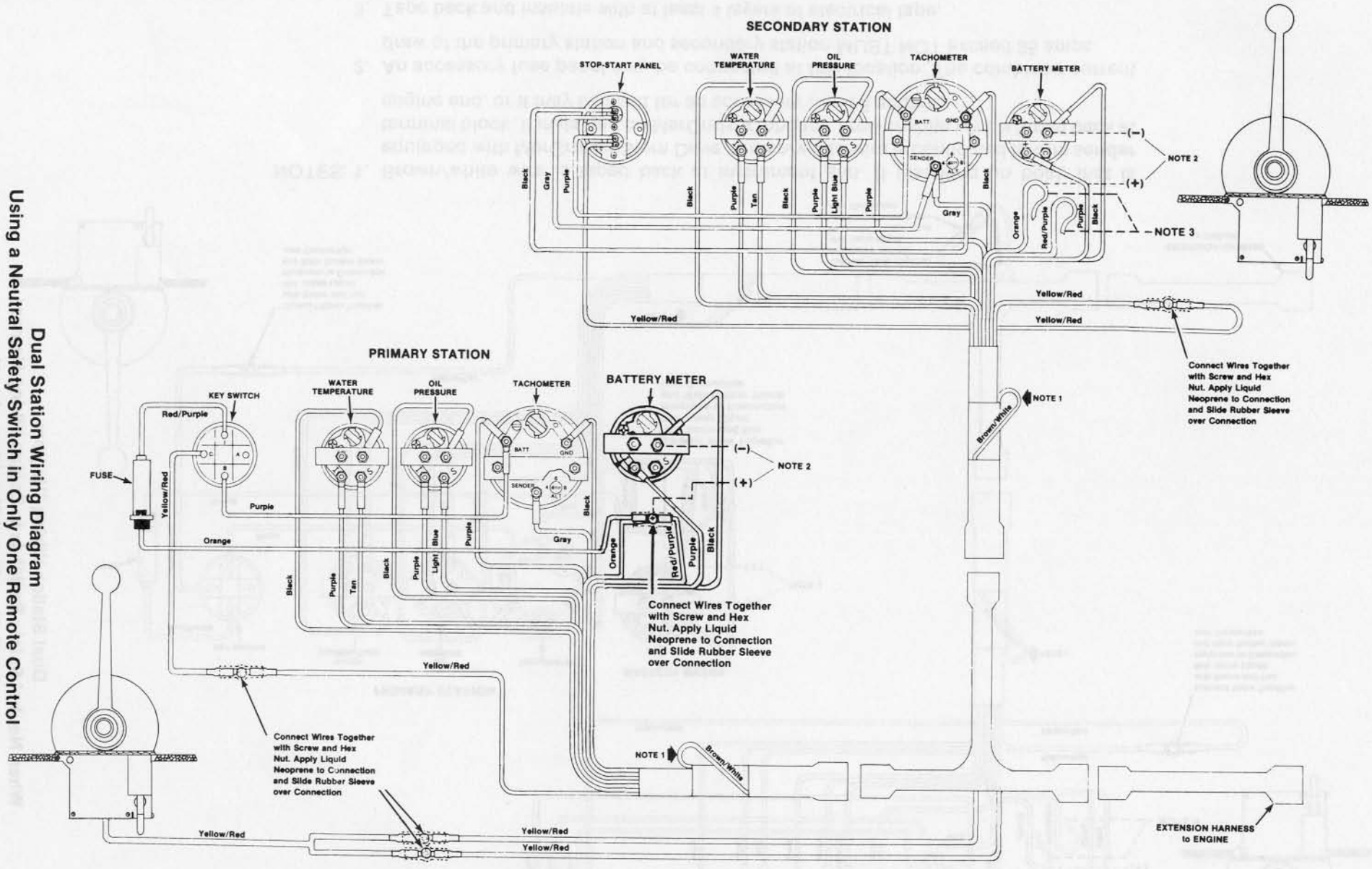


NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.

3. Tape back and insulate with at least 4 layers of electrical tape.

Dual Station Wiring Diagram
Using a Neutral Safety Switch in Only One Remote Control
(Battery Meter Circuit)

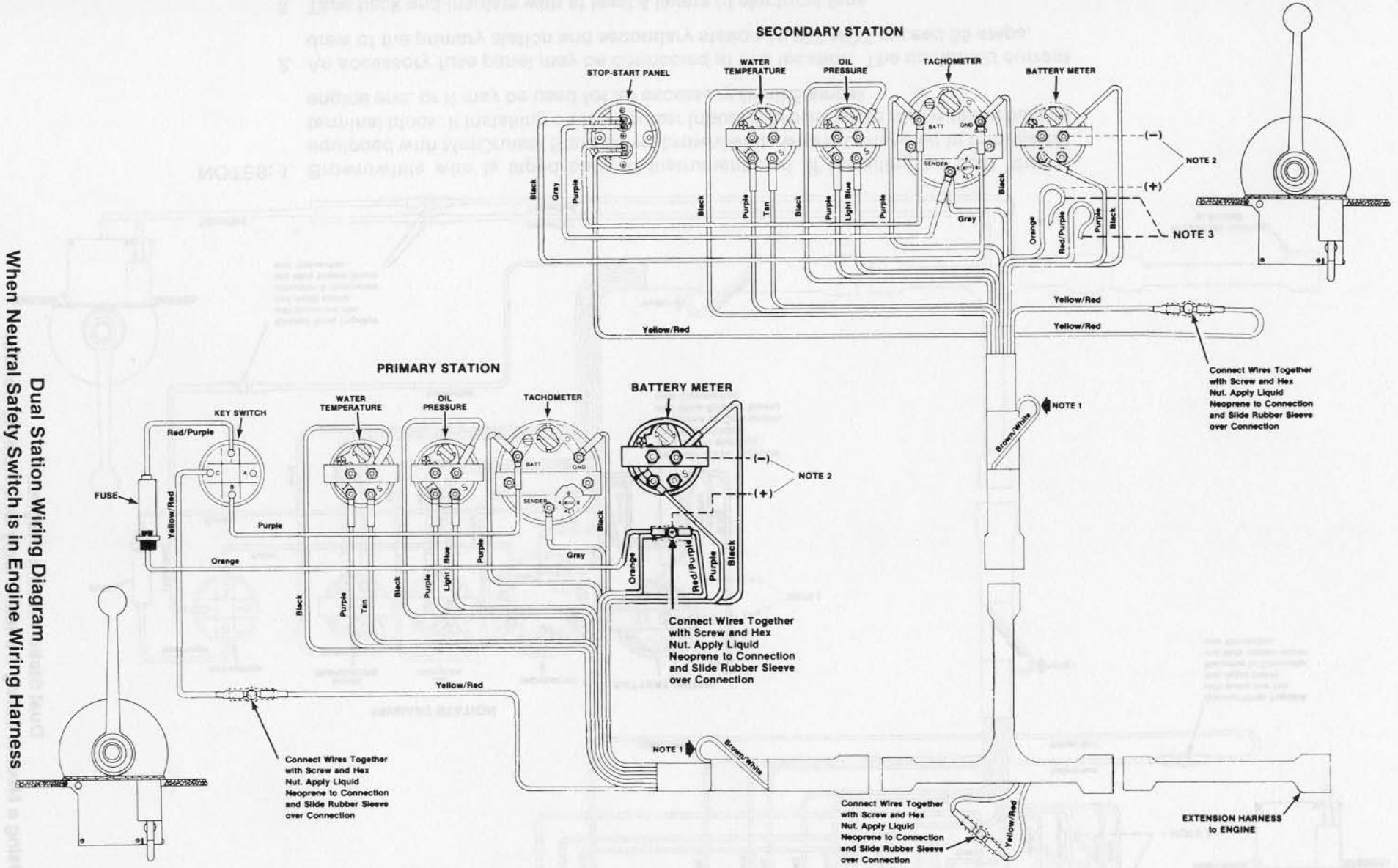


NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.

3. Tape back and insulate with at least 4 layers of electrical tape.

Dual Station Wiring Diagram
When Neutral Safety Switch is in Engine Wiring Harness
(Battery Meter Circuit)

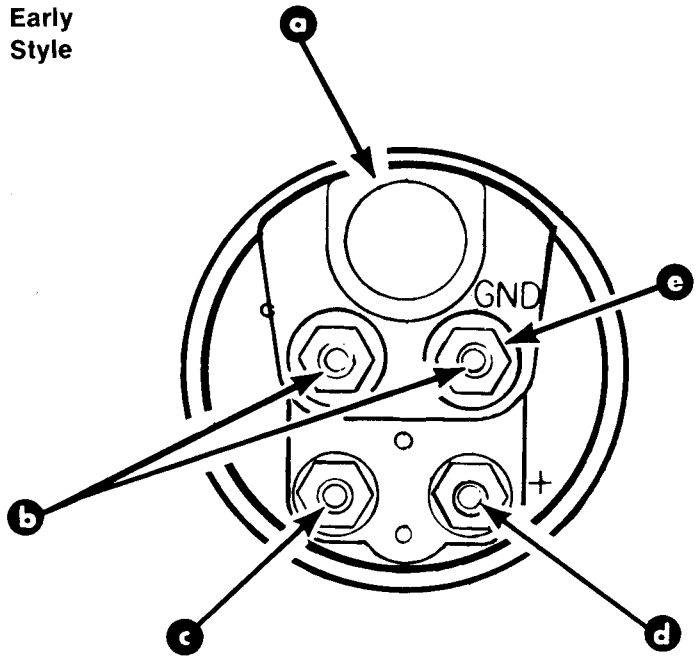


NOTES: 1. Brown/white wire is taped back at instrument end. If installing on boat, that is equipped with MerCruiser Stern Drive, brown/white wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, brown/white wire is taped back at engine end, or it may be used for an accessory (limit 5 amps).

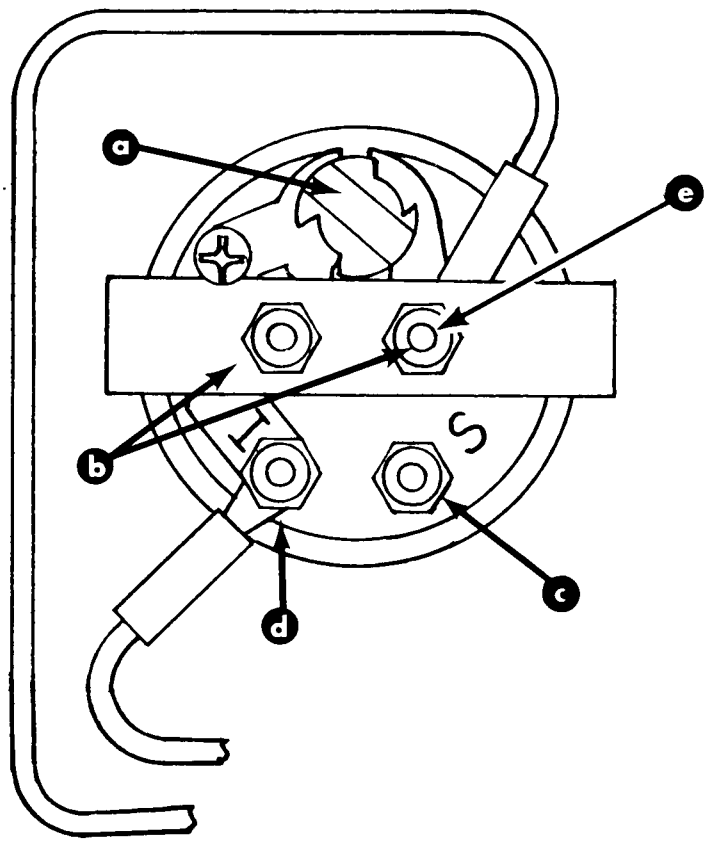
2. An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 35 amps.

3. Tape back and insulate with at least 4 layers of electrical tape.

Early Style

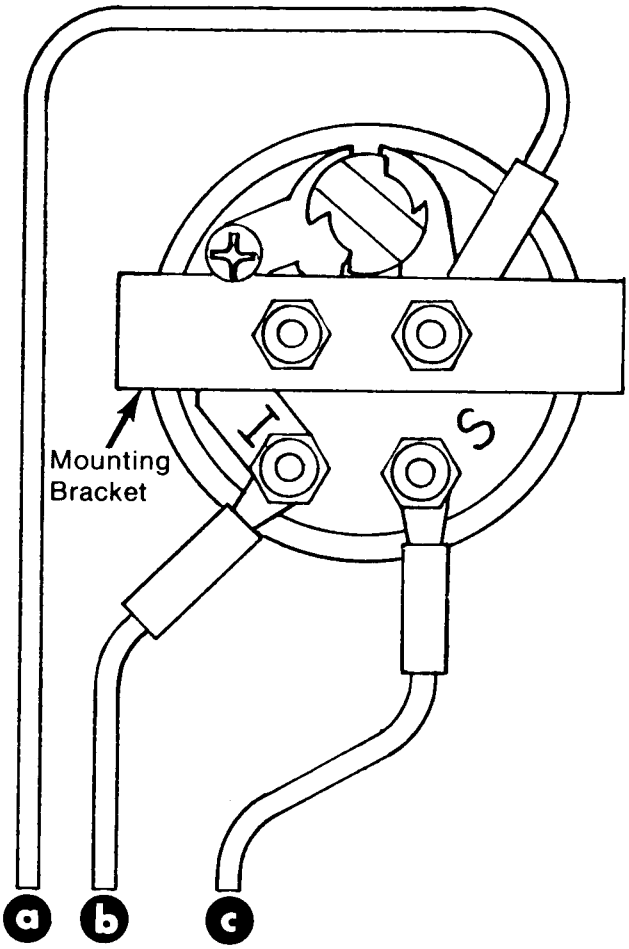


Later Style



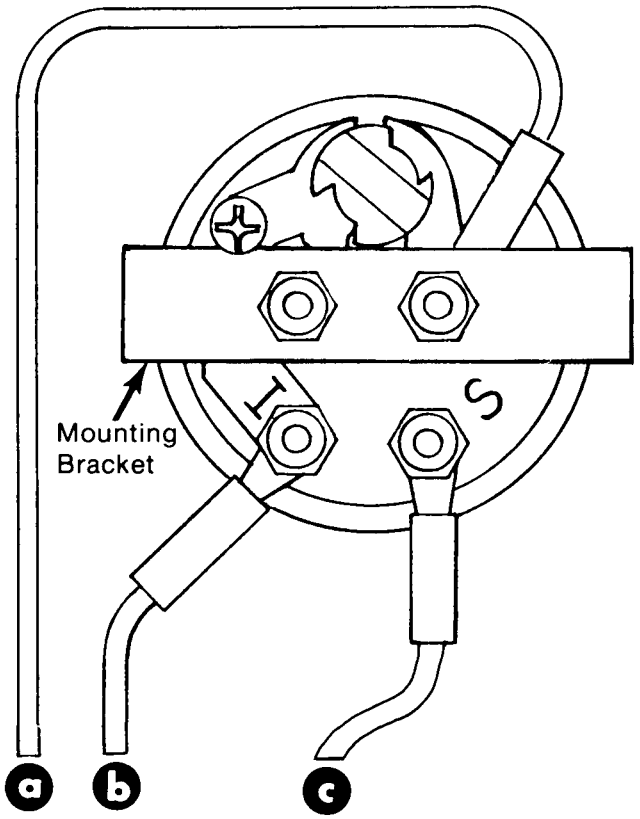
a - Lamp Mounting Hole
b - Gauge Mounting Studs
c - Terminal Not Used
d - Purple (or White) Jumper Wire from This Terminal to I (or +) Terminal on Water Temperature or Oil Pressure Guage
e - Black Jumper Wire from This Terminal to Ground Terminal on Water Temperature or Oil Pressure Gauge

Battery Meter Gauge



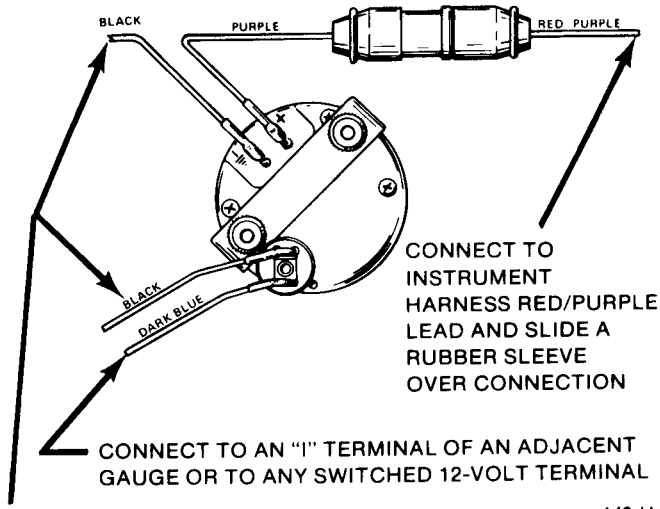
Temperature Gauge Resistor Kit 82-88645A3, If So Equipped

Earlier Model MerCruiser Color Code	BIA Color Code	Leads to —
(a) Black Wire	(a) Black	(a) Ground
(b) White Wire	(b) Purple	(b) Switched 12-Volt Terminal
(c) Orange Wire	(c) Light Blue	(c) Sender Lead



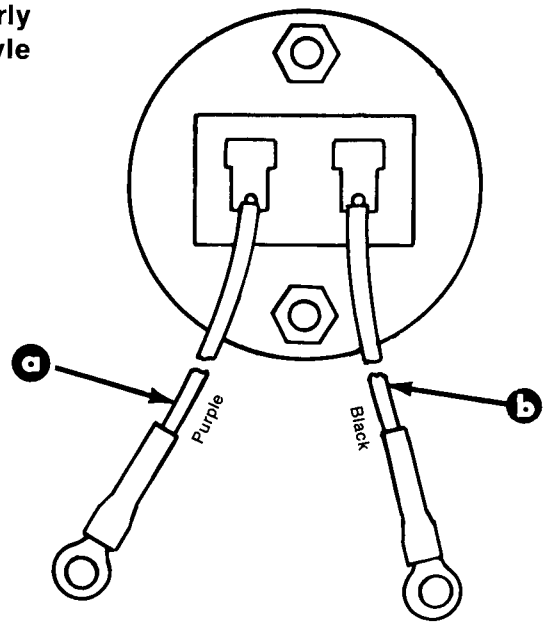
Oil Pressure Gauge

Earlier Model MerCruiser Color Code	BIA Color Code	Leads to —
(a) Black Wire	(a) Black	(a) Ground
(b) White Wire	(b) Purple	(b) Switched 12-Volt Terminal
(c) Orange Wire	(c) Light Blue	(c) Sender Lead



Clock

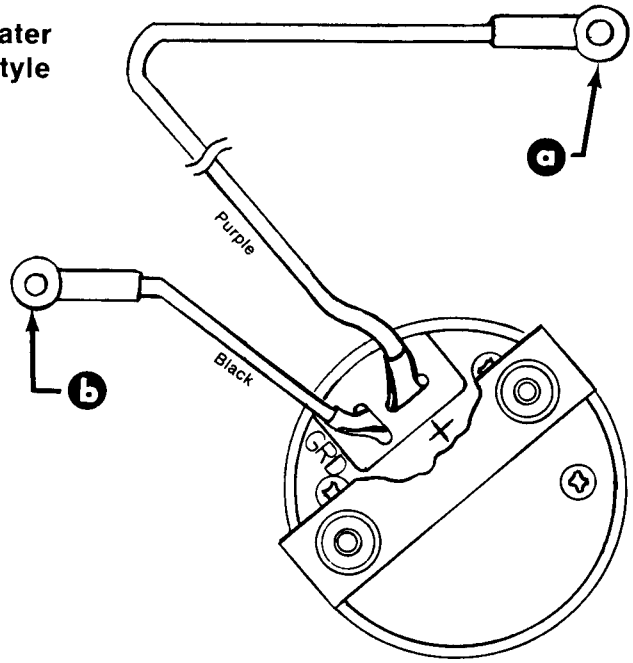
Early Style



a - Connect to Ignition Switch Activated 12-Volt Positive (+) source
b - Connect to Negative (-) Ground

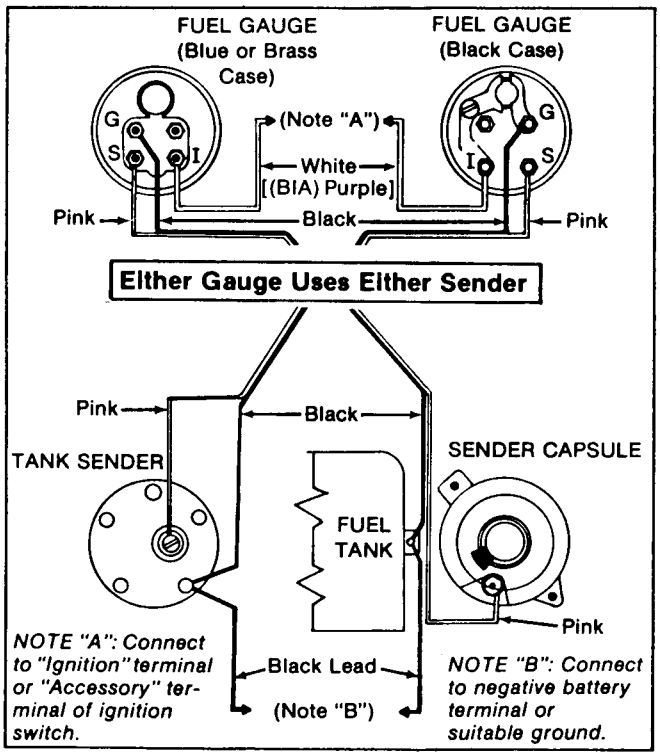
Cruiselog

Later Style

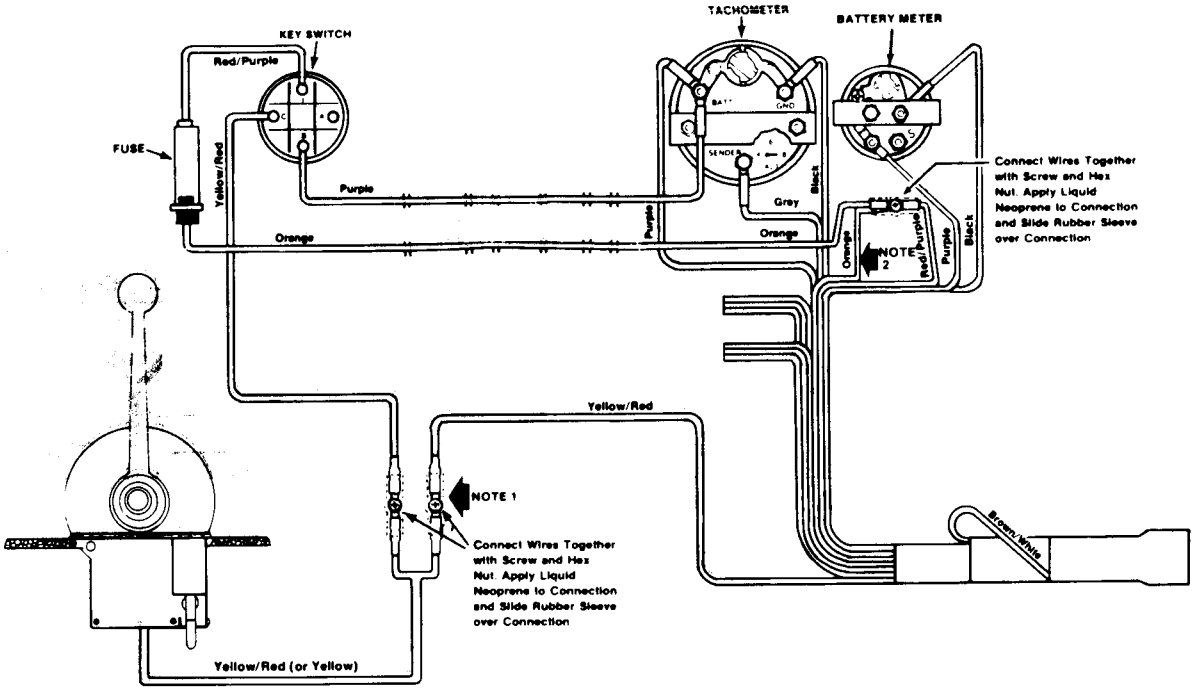


a - Connect to Ignition Switch Activated 12-Volt Positive (+) source
b - Connect to Negative (-) Ground

Cruiselog



Fuel Gauge and Sender



Key Switch Installation when Using Battery Meter and BIA Color-Coded Wiring Harness

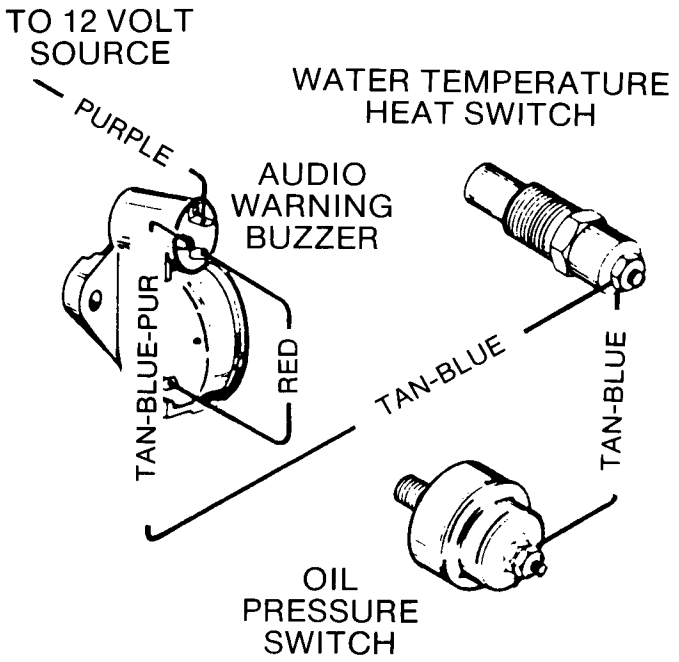
⚠CAUTION

Neutral start safety switch MUST BE USED in cranking circuit. If remote control does not incorporate this switch, it must be part of engine wiring.

NOTE 1. If engine is equipped with a neutral safety switch (on the engine or transmission), connect yellow/red ignition switch wire directly to yellow/red wiring harness wire with screw, nut and sleeve. A neutral safety switch MUST BE used in starting circuit to prevent accidental starting of engine when in gear.

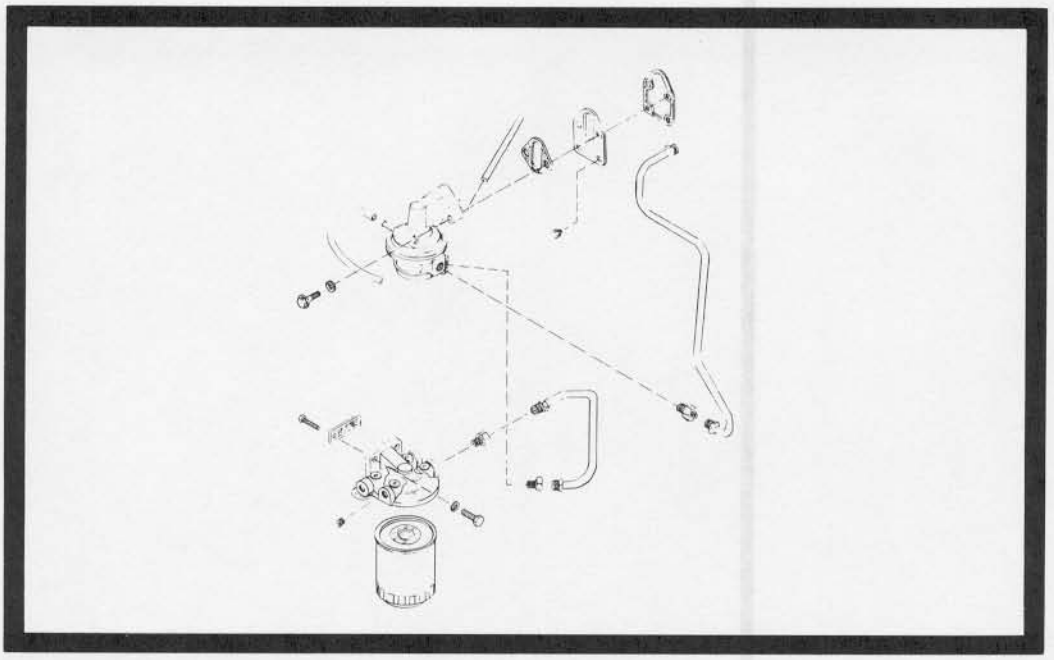
⚠CAUTION

Buzzer is not external ignition-proof, therefore, DO NOT mount buzzer in engine or fuel tank compartments.



Audio Warning System Wiring Diagram

FUEL SYSTEM



FUEL DELIVERY SYSTEM

5
A

mercruiser
STERN DRIVES & INBOARDS

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Tools/Lubricants/Sealants

TOOLS OBTAINED LOCALLY
Fuel Pressure Gauge

LUBRICANTS/SEALANTS	
92-34227-2	Quicksilver Perfect Seal
92-825265A1	Quicksilver Needle Bearing Assembly Lubricant

SEALANTS OBTAINED LOCALLY
Loctite Pipe Sealant with Teflon

Precautions

⚠WARNING
ALWAYS disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller wil be damaged, and subsequent overheating damage may result.

⚠WARNING
Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is "OFF". DO NOT smoke or allow sources of spark or flame in the area while working. Wipe up any spilled fuel immediately.

⚠WARNING
Make sure that no fuel leaks exist, before closing engine hatch.

Fuel Delivery System

Recommendations

⚠WARNING
Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

When designing and installing fuel delivery system, the following information MUST BE observed:

1. Fuel tank should be mounted below carburetor level, if possible. If tank is mounted above carburetor level, gravity feed may cause carburetor fuel inlet needle to unseat, and flooding may result.
2. Fuel pickup should be at least 1" (25mm) from the bottom of the fuel tank to prevent picking up water or other impurities.
3. Fuel lines used MUST BE Coast Guard approved (USCG type A) and MUST NOT BE SMALLER THAN 3/8" (9.5mm) ID. On installations where long lines or numerous fittings are required, larger size lines should be used.
4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.

Description

The fuel system consists of a fuel tank(s), a water separating fuel filter (if so equipped), a fuel pump, and a carburetor.

The fuel is stored in the fuel tank. When the engine is cranking or running, fuel is drawn from the fuel tank, through the water separating filter (if so equipped), by a mechanically operated fuel pump. The fuel pump is operated by the engine camshaft.

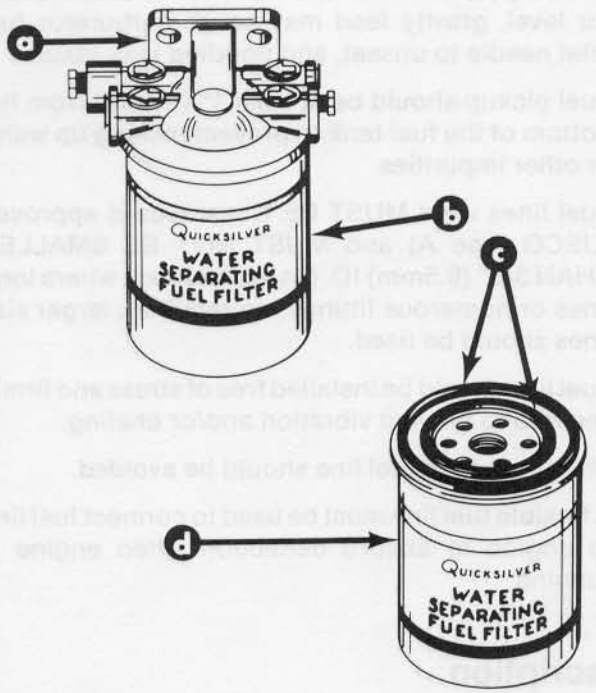
The fuel is pushed through the fuel pump to the carburetor where it is metered and fed to the engine.

Water Separating Fuel Filter

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

The water separating fuel filter can be purchased as an option for engines not equipped with it.

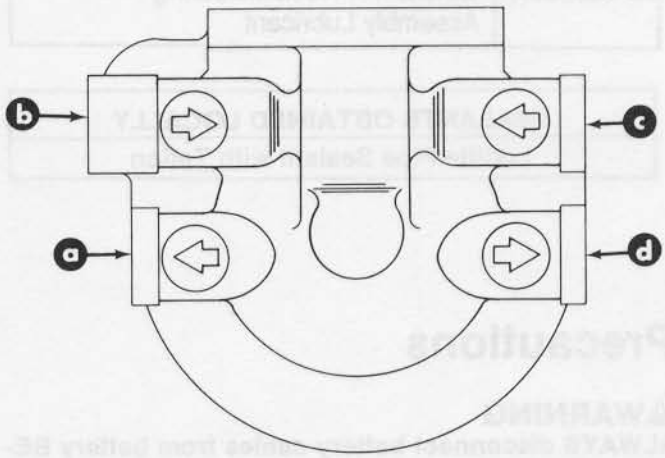
The fuel filter consists of the fuel filter base and filter element



a - Filter Mounting Base
b - Filter Element
c - Sealing Rings
d - Replacement Element

IMPORTANT: If installing water separating fuel filter as an option, filter should be located between fuel tank and fuel pump. Also fuel inlet and outlet lines must be connected correctly for filter to work properly. Follow instructions supplied with water separating fuel filter kit.

⚠CAUTION
Coat fuel line fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.



a - Fuel Outlet if "C" is the Inlet
b - Fuel Inlet if "D" is the Outlet
c - Fuel Inlet if "A" is the Outlet
d - Fuel Outlet if "B" is the Inlet

Replacement

1. Disconnect negative and positive battery leads from battery.
2. Remove filter element from mounting base by turning counterclockwise. You may need a filter wrench to break element loose.

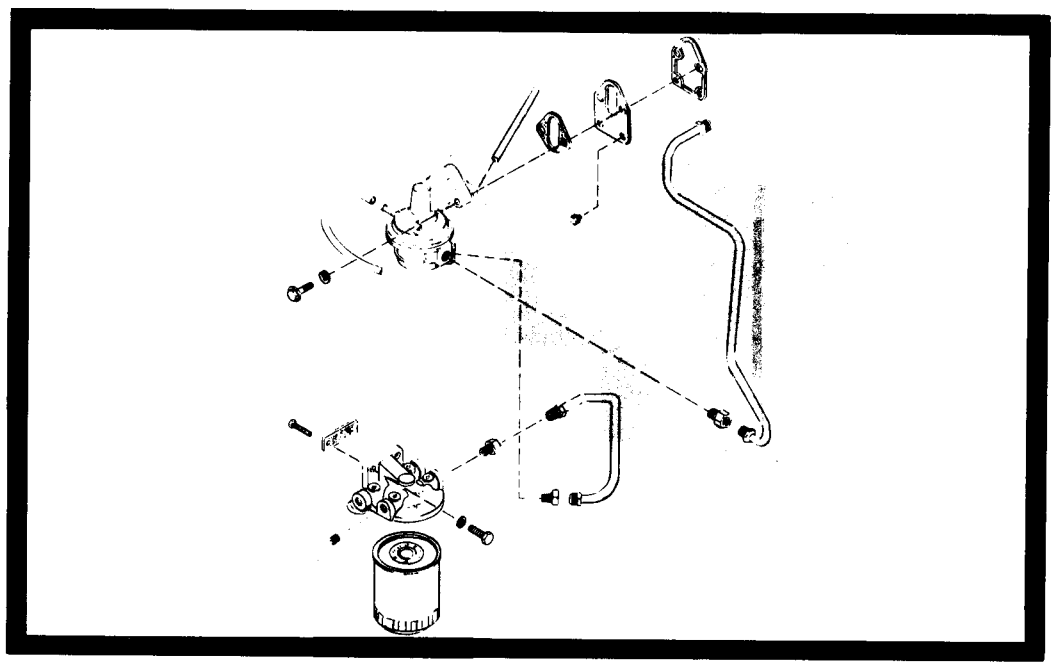
IMPORTANT: Element cannot be cleaned and reused, it must be replaced.

3. Lubricate sealing rings with engine oil.
4. Install new element. Tighten securely by hand.
5. Start engine (making sure water is supplied to cooling system) and check for fuel leaks.

a - Remove Old Filter
b - Lubricate Sealing Rings with Engine Oil
c - Install New Filter (Tighten Securely By Hand Only)

Replacing Water Separating Fuel Filter

FUEL SYSTEM



FUEL PUMP

5

B

mercruiser
STERN DRIVES & INBOARDS

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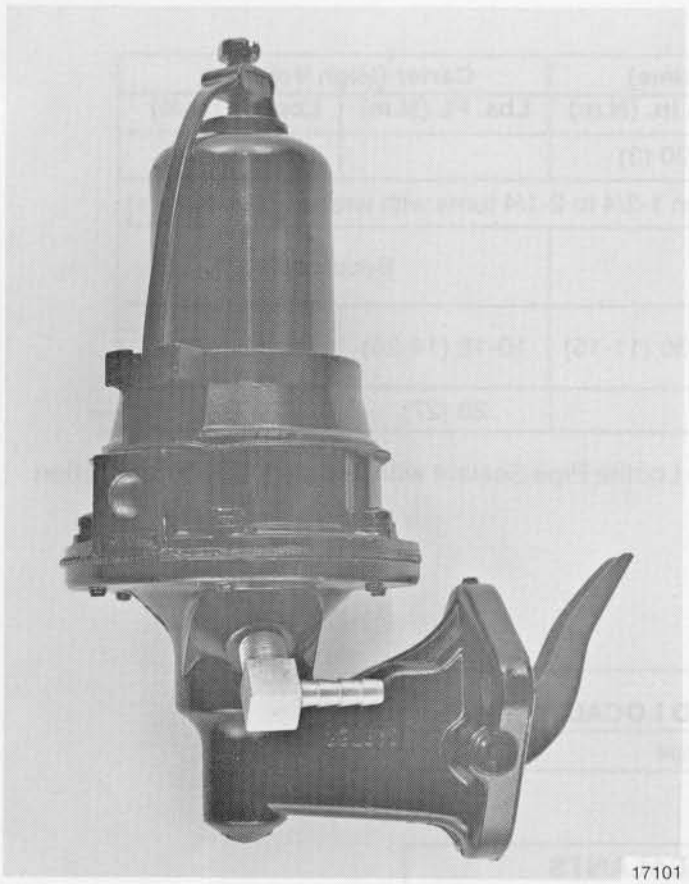
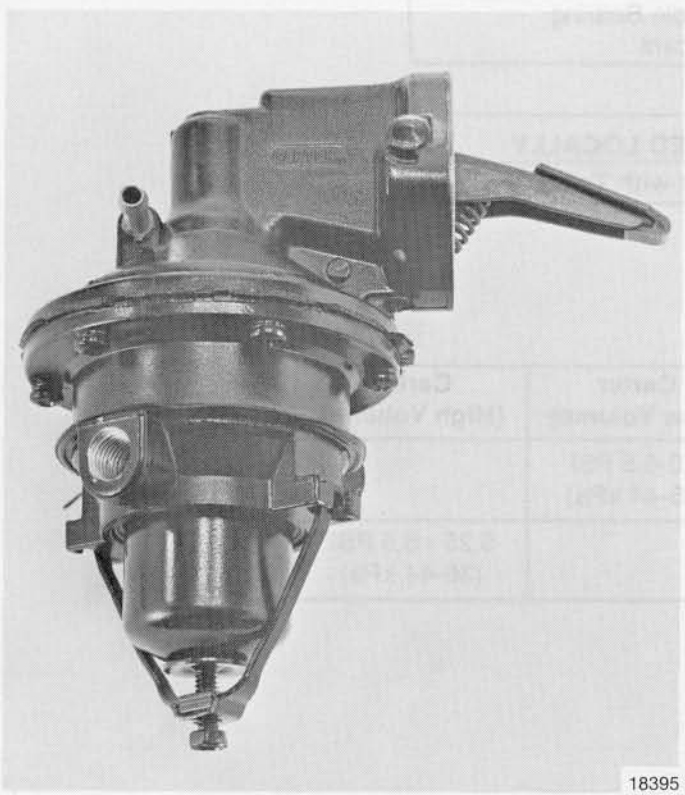
Identification



Carter Pump (Low Volume)



Carter Pump (High Volume)

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	Carter (Low Volume)		Carter (High Volume)	
	Lbs. Ft. (N.m)	Lbs. In. (N.m)	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Diaphragm Screws		30 (3)		
Fuel Inlet Fitting*	Tighten finger tight, then 1-3/4 to 2-1/4 turns with wrench (See Note 1)			
Fuel Line to Fuel Outlet Fitting	Securely		Securely	
Fuel Outlet Fitting (Note 1)*		95-130 (11-15)	10-18 (14-25)	
Fuel Pump to Block	20 (27)		20 (27)	

NOTE 1: Coat fuel line inlet and outlet fitting threads with Loctite Pipe Sealant with Teflon, DO NOT use teflon tape.

Tools/Lubricants/Sealants

TOOLS OBTAINED LOCALLY
Fuel Pressure Gauge

LUBRICANTS/SEALANTS	
92-34227-2	Quicksilver Perfect Seal
92-825265A1	Quicksilver Needle Bearing Assembly Lubricant

SEALANTS OBTAINED LOCALLY
Loctite Pipe Sealant with Teflon

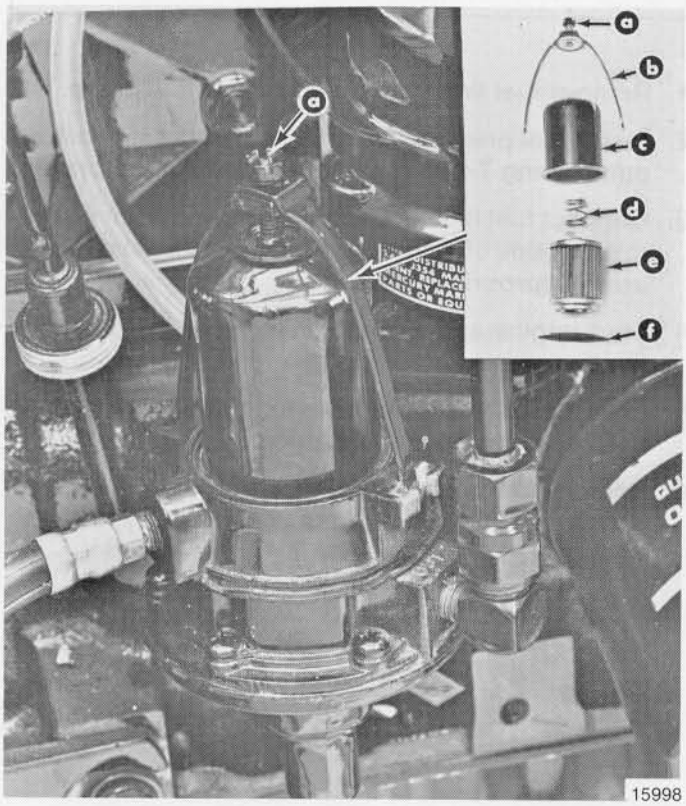
Specifications

Type of Fuel Pump	Carter (Low Volume)	Carter (High Volume)
Pump Pressure (1000 RPM)	5.0-6.5 PSI (35-44 kPa)	
Pump Pressure (1800 RPM)		5.25 - 6.5 PSI (36-44 kPa)

Fuel Pump Fuel Filter Replacement

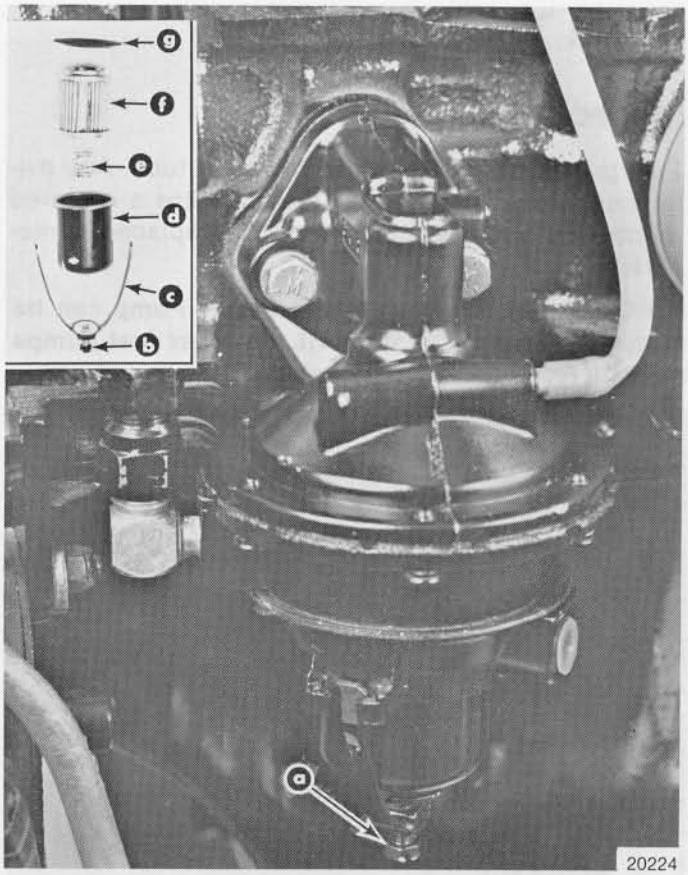
NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove safety wire.
2. Loosen screw above filter bowl and release bail from fuel pump housing.
3. Remove bowl, filter element, spring, and gasket from fuel pump.
4. Install new filter as shown.



a - Retaining Screw (Lockwired)
b - Bail - Hook Ends in Slots
c - Filter Bowl
d - Spring
e - Filter Element - Open End of Filter TOWARD PUMP
f - New Gasket

Carter Pump (Low Volume)



a - Lockwire
b - Retaining Screw
c - Bail - Hook Ends in Slots
d - Filter Bowl
e - Spring
f - Filter Gasket - Open End at Filter TOWARD PUMP
g - New Gasket

Carter Pump (High Volume)

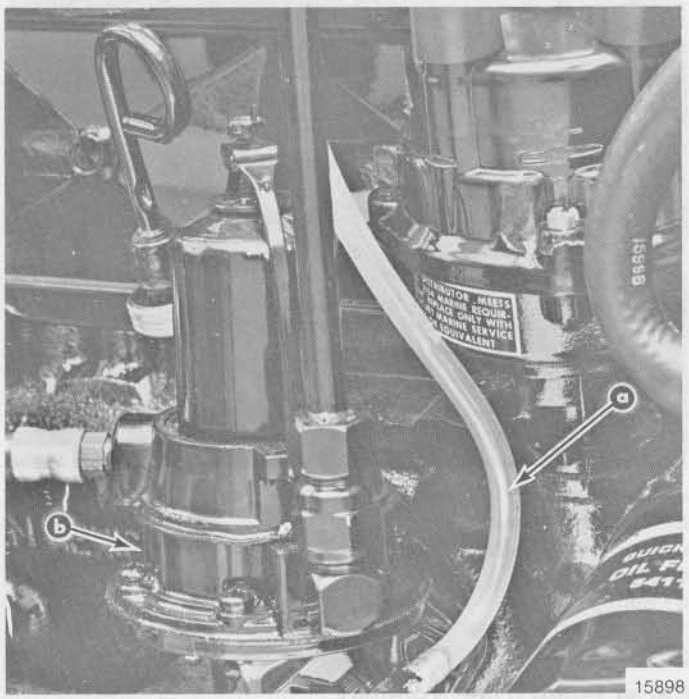
5. Tighten retaining screw securely.
6. Install safety wire and tighten securely.
7. Start and run engine.
8. Check for gasoline leaks.
9. If leaks exist, STOP ENGINE and recheck connections.

Sight Tube

Inspection

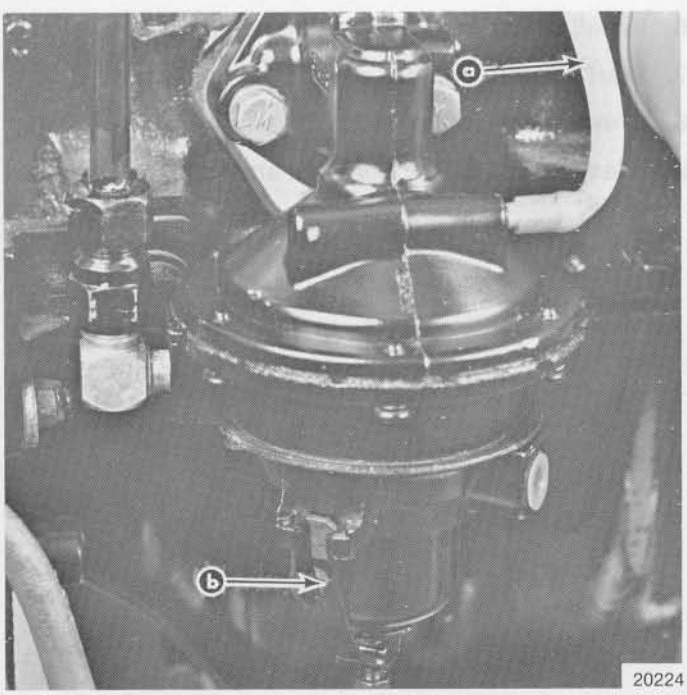
Fuel pumps are equipped with a sight tube. Any evidence of fuel in the sight tube indicates a ruptured diaphragm and fuel pump must be replaced immediately.

IMPORTANT: The low volume Carter Pump can be repaired with a diaphragm kit. All other fuel pumps must be replaced as an assembly.



a - Sight Tube b - Fuel Pump

Carter Pump (Low Volume)



a - Sight Tube b - Fuel Pump

Carter Pump (High Volume)

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite sealant with teflon (do not use teflon tape). Torque to specifications.

Testing Fuel Pump

NOTICE

Refer to "Precautions", in this section, BEFORE proceeding.

1. Remove fuel line from outlet side of fuel pump.
2. Install fuel pressure test gauge to outlet side of fuel pump using T-fitting and appropriate adaptors.
3. Connect fuel line (previously removed from pump) to other side of T-fitting on fuel pressure test gauge using appropriate adaptors.
4. Start engine and run at R.P.M. listed in specifications.
5. Fuel pressure should be within specifications. If not, repair or replace fuel pump.
6. Remove fuel pressure gauge and adaptors. Reconnect fuel line to fuel pump. Tighten to specifications.

Carter Pump (Low Volume)

NOTICE
Refer to "Precautions", in this section, BEFORE proceeding.

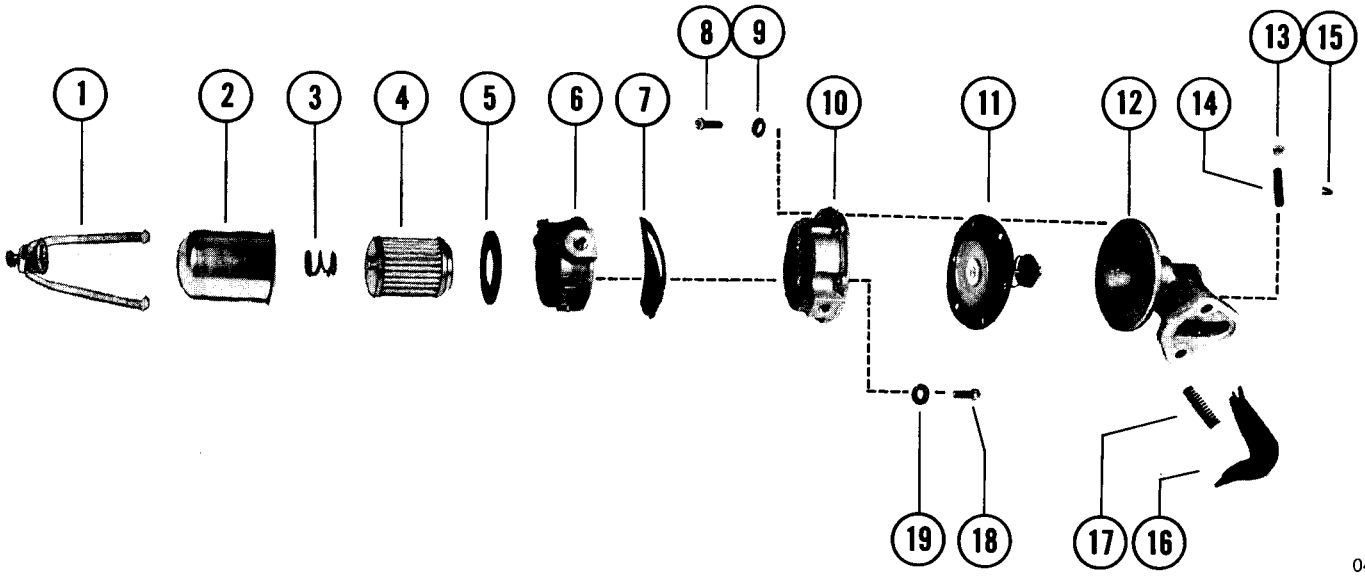
Removal

⚠CAUTION
Plug fuel lines after disconnecting from fuel pump to eliminate any change of fuel siphoning into bilge.

1. Disconnect fuel inlet and outlet lines at fuel pump.
2. Remove sight tube.
3. Remove 2 fuel pump mounting bolts and lockwashers, pump and gasket.

Disassembly

1. Mark edges of fuel cover and body flange. Parts then may be reassembled in same relative position.
2. Loosen screw and remove filter holder, filter and gasket.
3. Remove screws and pump body.
4. Remove screws and lockwasher and separate lower housing, pulsator, diaphragm and valve housing.
5. Remove spring, rocker arm shaft plug, safety pin, rocker arm shaft and rocker arm from main body.
6. Remove diaphragm seal assembly.



1 - Filter Cover Retainer
2 - Filter Cover
3 - Filter Spring
4 - Filter
5 - Filter Gasket
6 - Pulsator Housing
7 - Pulsator
8 - Screw
9 - Lockwasher
10 - Valve Body
11 - Diaphragm
12 - Pump Body
13 - Rocker Arm Pin Plug
14 - Rocker Arm Pin
15 - Rocker Arm Retainer
16 - Rocker Arm
17 - Rocker Arm Spring
18 - Screw
19 - Lockwasher

Low Volume Carter Fuel Pump

Cleaning and Inspection

1. Clean and rinse all metal parts in solvent. Blow out all passages with compressed air.
2. Inspect pump body and fuel cover for cracks, breakage and distorted flanges. Examine all screw holes for stripped or crossed threads. **Replace pump assembly if one of main castings is not serviceable.**
3. Inspect rocker arm and link for excessive wear and for loose hinge pin.
4. Use proper diaphragm repair kit to replace diaphragm.
5. Replace rocker arm spring and diaphragm springs as removed. Old springs may be distorted, weak or corroded.
6. Check condition of valves by pushing each valve off its seat with a thin rod or pencil. Insert hooked wire thru inlet opening in fuel cover to move fuel inlet valve off its seat. If a valve sticks to its seat, if it moves off its seat and does not rebound or, if cage is damaged, complete valve must be replaced. To remove valves, clear staked metal (with a sharp chisel, file or suitable scraper) and pull valve out with a hook-shaped tool.

Reassembly

1. Replace diaphragm, pulsator, filter gasket and rocker arm shaft plug.
2. Push diaphragm into pump body and install rocker arm so that fork catches diaphragm.
3. Install rocker arm shaft, safety pin and rocker arm shaft plug.
4. Attach valve housing to lower housing with 2 screws.
5. Assemble pump bodies with screws, making sure that marks line up. Torque to specifications.

IMPORTANT: Diaphragm must be flexed to its full stroke while tightening cover screws, or pump diaphragm protector will not be properly centered, thereby rubbing on the pump body casting and wearing diaphragm.

6. Reassemble filter to pump body, using new filter as previously outlined.

Installation

1. Install new gasket (coat both sides with Perfect Seal) on fuel pump. Install pump and torque mounting bolts to specifications.
2. Install fuel line to fuel outlet fitting. Tighten securely.
3. Install fuel inlet fitting to fuel pump. Torque to specifications.

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

4. Install sight tube and fuel supply line.
5. Start engine and check for fuel leaks.

Carter Pump (High Volume)

NOTICE
Refer to "Precautions", in this section, BEFORE PROCEEDING.

IMPORTANT: The high volume carter pump cannot be repaired. If fuel pump fails it must be replaced.

Replacement

1. Remove fuel inlet and outlet lines at fuel pump.
2. Remove sight tube.
3. Remove 2 fuel pump mounting bolts and lockwashers, pump and gasket.

⚠CAUTION

Plug fuel lines after disconnecting from fuel pump to eliminate any change of fuel siphoning into bilge.

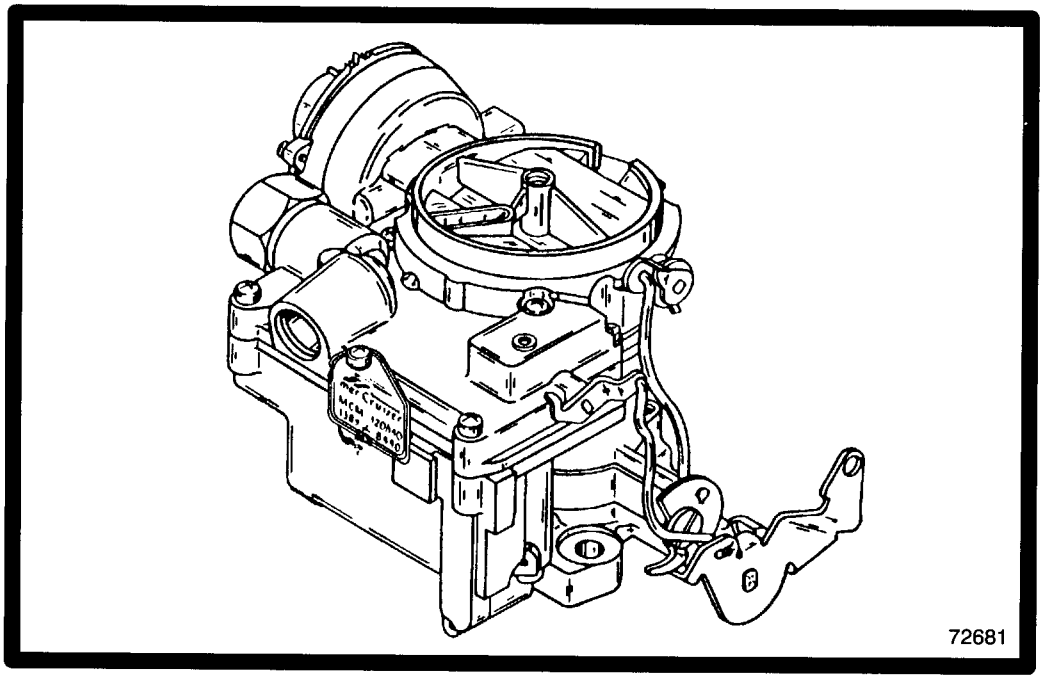
4. Install new gasket (coat both sides with Perfect Seal) on fuel pump. Install pump, and torque mounting bolts to specifications.
5. Install fuel line to fuel outlet fitting. Tighten securely.
6. Install fuel inlet fitting to fuel pump. Torque to specifications.

⚠CAUTION

Coat fuel line inlet fitting threads with Loctite pipe sealant with teflon (do not use teflon tape). Torque to specifications.

7. Install sight tube and fuel supply line.
8. Start engine and check for fuel leaks.

FUEL SYSTEM



2 BARREL CARBURETOR

5

C

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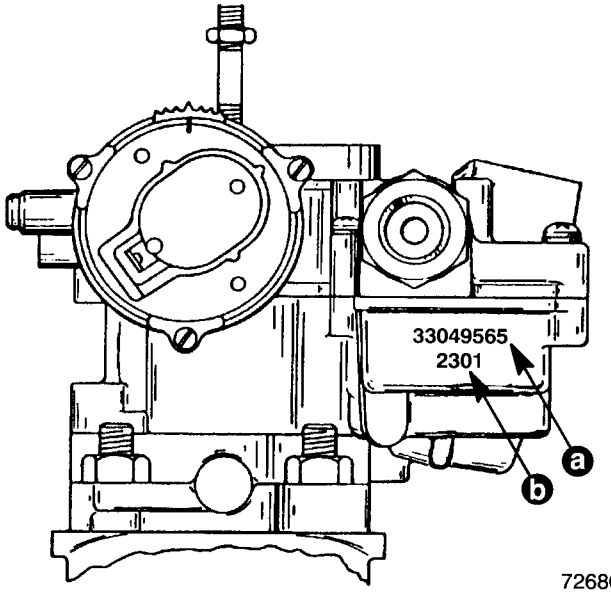
Identification



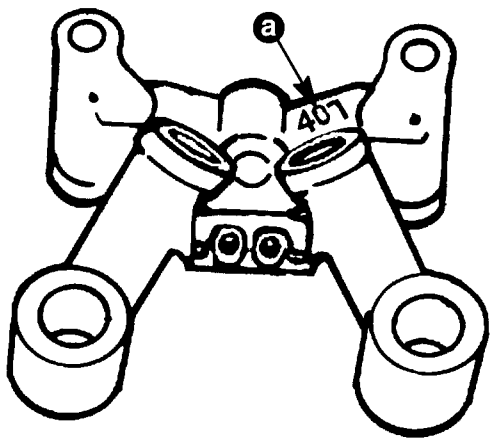
72680

a - Part Number
b - Date Code

Carburetor Part Number Location

Data Code Explanation: Example 2301

First Figure is Year:
4 = 1984, 5 = 1985, etc.
Second Figure is Month:
2 = February, 3 = March, etc.
X = October, Y = November, Z = December
Third and Fourth Figures are Day of Month:
01 = First day, 02 = Second day, etc.



72779

a - Identification Number (See Specifications)

Venturi Cluster Identification

Replacement Parts Warning

⚠ WARNING

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Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	Lb. Ft. (N•m)
Carburetor to Manifold	20 (27)
Fuel Line to Carburetor	18 (24)
Fuel Inlet Filter Nut	18 (24)

Tools

Part Number	Description
79-17391A1	Tachometer
91-36392	Universal Carburetor Gauge

Borroughs Special Tools

Can be ordered from: Borroughs Tool & Equip. Corp.
2429 N. Burdick Street
Kalamazoo, MI 49007
Phone: (616) 345-5163

Part Number	Description
BT-8128 B	Float Gram Scale

Specifications

UNIT OF MEASUREMENT In. (mm)

CARBURETOR ADJUSTMENT SPECIFICATIONS

All measurements are ± 1/64 in. (0.4 mm).

Engine Model	MCM 120/140 2.5 /3.0L
Part Number	1389-9350 1389-9562 3310-806077
Float Level : 2 Piece Solid Inlet Needle	3/8 (10)
Spring Loaded Inlet Needle	9/16 (14)
Float Drop (Note1)	1-3/4 (32 mm)
Pump Rod	1-5/32 (29)
Choke Setting	One Mark Right Of Index Marks
Choke Unloader	.080 [5/64] (0.2)
Idle Mixture Screw Preliminary Setting	1-1/4 Turns
Float Weight	9 Grams Max.
Primary Jet Size	1.45
Venturi Cluster ID Number	442
Power Valve Size	0.84 mm

Note 1:Measured from air horn (with gasket in place) to toe of float.

Important Service Information

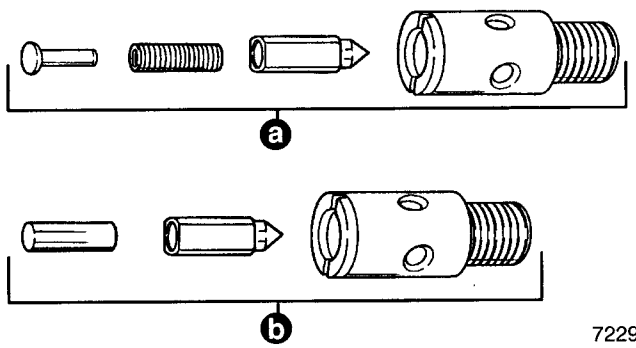
Flooding at Idle RPM

If your engine floods at idle RPM, check the following:

1. Problem in ignition system causing engine to run rough.
2. Idle mixture screw adjusted incorrectly.
3. Bad needle and seat.
4. Incorrect float level drop.

Needle/Seat Change

If the preceding steps failed to correct the problem, change the needle/seat to the other type. MerCarbs are equipped with either the solid or the spring loaded needle.

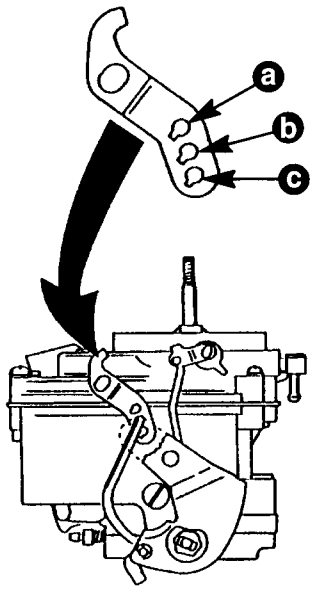


a - Spring Loaded Type Needle
b - Solid Type Needle

Needle and Seat Assemblies

Adjustable Accelerator Pump Lever

This new 3-holed lever will allow you to change the amount of fuel delivered to the engine by the accelerator pump. The hole closest to the lever's shaft will give the same amount of fuel as the single hole lever did. The center hole gives approximately 0.5 cc less fuel and the hole farthest away will give about 1.0 cc less fuel.



73131

a - Full Accelerator Pump Stroke
b - 0.5 cc Less Fuel per Stroke
c - 1.0 cc Less Fuel per Stroke

The technician should be able to correct most "bogging" problems with this 3-holed lever, providing the "bogging" is caused by the carburetor. When installing the 3-holed lever, remove any metal ball that someone may have put in the accelerator pump well to limit pump travel. Also, make sure that the duration spring on the accelerator pump is stock and hasn't had several coils cut off. Make sure the venturi cluster is the correct one as outlined previously under "Specifications."

High Altitude Re-Jetting

Engine flooding problems, at idle RPM, are generally related to the altitude (above sea level) at which they are operated.

If engine is running too rich at higher elevation, order a smaller jet from the chart. A jet stamped "145" is a 1.45 mm jet.

Jet Size (mm)	Quicksilver Part Number
1.35	3302-11850
1.40	3302-811851
1.45	3302-9050

Description

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel/air mixture to the engine.

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

Fuel Supply Connections

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

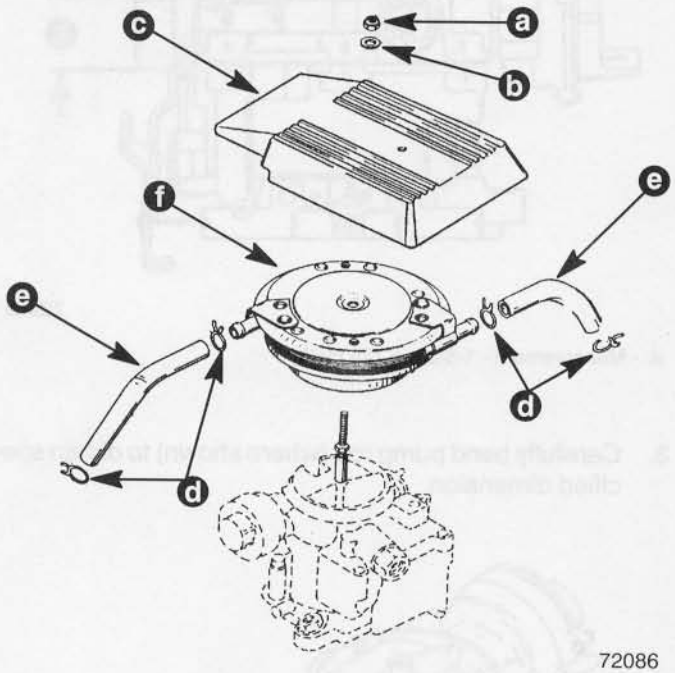
Flame Arrestor with Carburetor Cover

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Nut.
   b. Sealing washer.
   c. Carburetor cover.
   d. Crankcase ventilation hoses from flame arrestor and rocker arm covers.
   e. Flame arrestor.
2. Clean and inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

3. Install in the following order:
   a. Flame arrestor.
   b. Crankcase ventilation hoses to flame arrestor and rocker arm covers.
   c. Carburetor cover.
   d. Sealing washer.
   e. Nut (tighten securely).

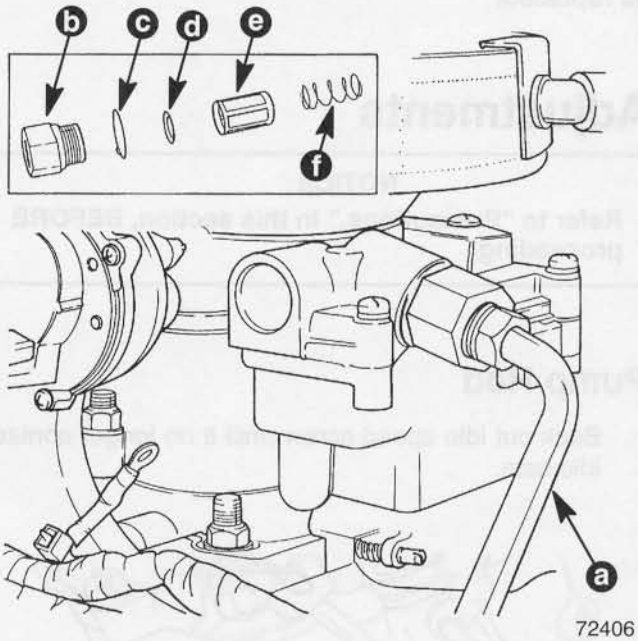


a - Nut
b - Sealing Washer
c - Carburetor Cover
d - Cable Tie
e - Crankcase Ventilation Hose
f - Flame Arrestor

Fuel Inlet Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Fuel line from fuel inlet filter nut.
   b. Fuel inlet filter nut and small gasket.
   c. Large gasket.
   d. Filter.
   e. Spring.
   f. Small gasket - from inside filter nut.



a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

2. Clean filter nut and spring in solvent and dry with compressed air.
3. Install in the following order:
   a. Spring - place in carburetor body.
   b. Filter - open end to inlet filter nut.
   c. Small gasket - place inside filter nut.
   d. Large gasket - place over filter nut threads.
   e. Fuel inlet filter nut - torque nut to 18 lb. ft. (24 N•m).
   f. Fuel line - torque to 18 lb. ft. (24 N•m).

Choke Inspection

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine turned OFF, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Follow directions on can.

IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

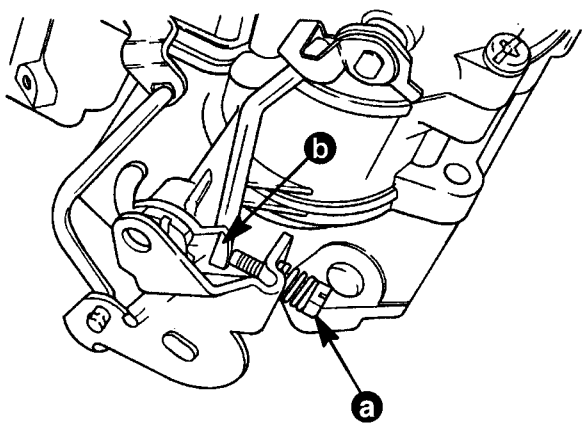
Adjustments

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

Pump Rod

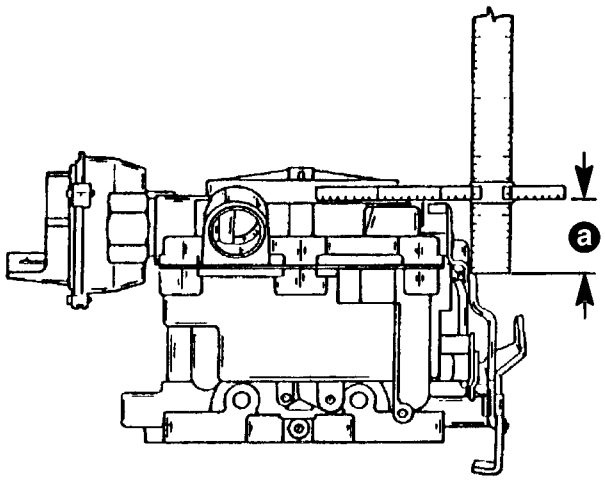
1. Back out idle speed screw until it no longer contacts idle cam.



72284

a - Idle Speed Screw
b - Idle Cam

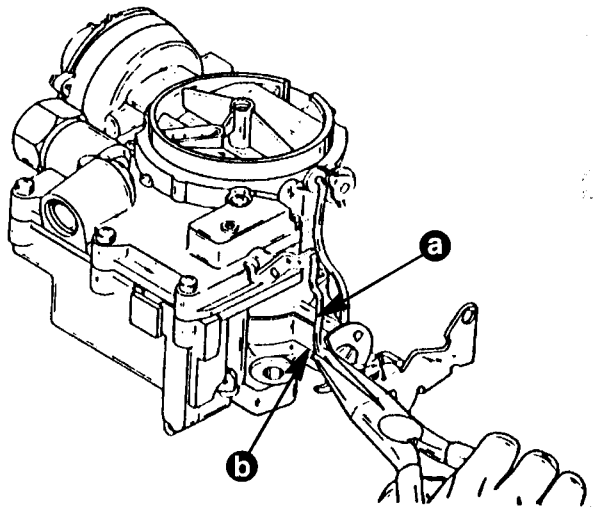
2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.



72682

a - Measurement - 1-5/32 in. (29 mm)

3. Carefully bend pump rod (where shown) to obtain specified dimension.

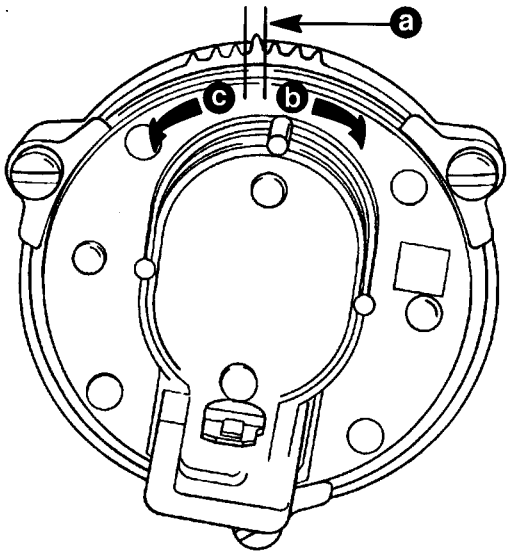


72683

a - Pump Rod
b - Bend Here

Choke Setting

Normal choke setting is such that scribed mark on cover is one mark right of the long case mark on choke housing.



72403

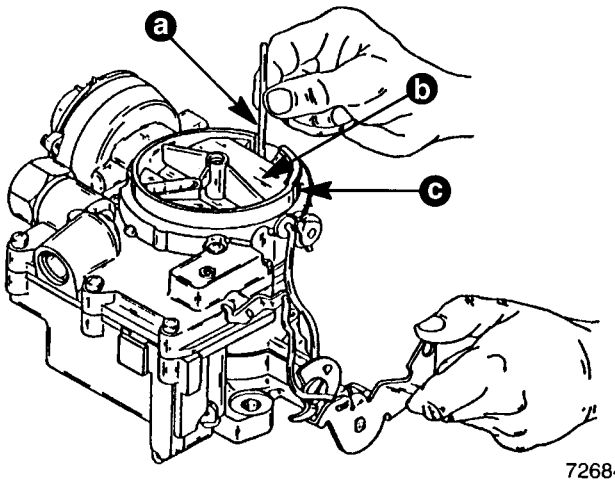
a - Scribed Mark
b - More Choke
c - Less Choke

If choke adjustment is necessary:

1. Loosen three choke cover retaining screws and adjust as shown.
2. Tighten three choke cover retaining screws securely.

Choke Unloader

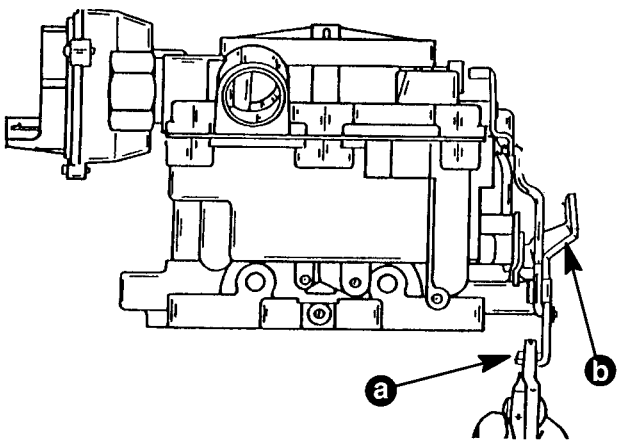
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. [5/64 in.] (0.2 mm) drill rod, or appropriate gauge, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



72684

a - .080 In. (0.2 mm) Drill Rod
b - Choke Plate
c - Air Horn

4. Bend tang on throttle lever, if necessary, to obtain specified dimension.



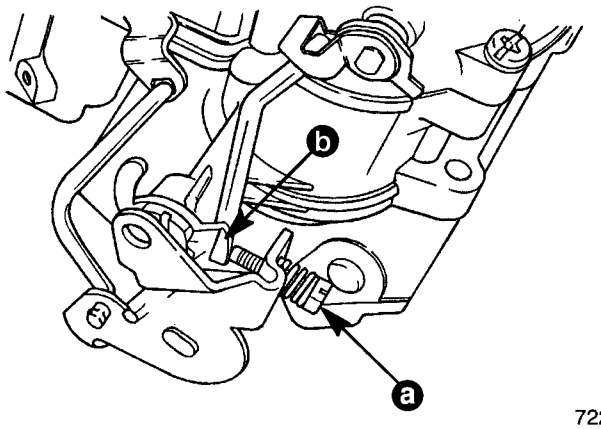
72685

a - Tang
b - Throttle Level

Preliminary Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Back out idle speed screw until it no longer contacts idle cam. Turn idle speed screw in until it just contacts idle cam, then turn screw in an additional two turns.

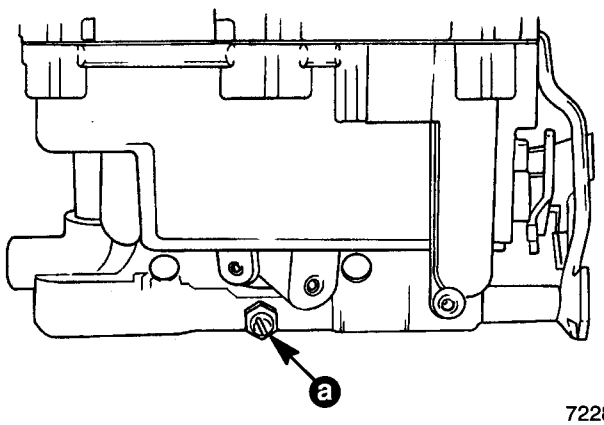


72284

a - Idle Speed Screw
b - Idle Cam

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needle in until lightly seated, then back needle out 1-1/4 turns.



72281

a - Idle Mixture Needle

Final Idle Speed and Mixture

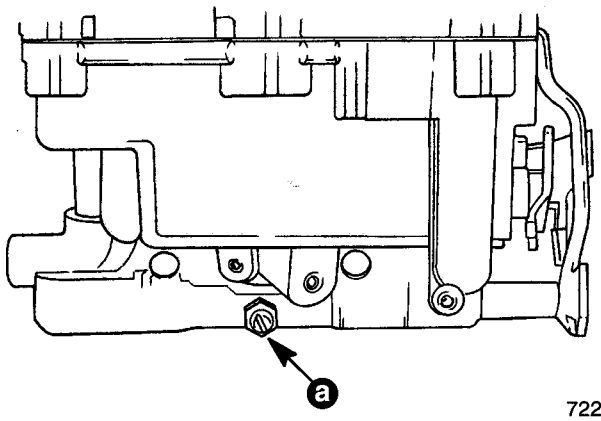
IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications," with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect an accurate shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needle tightly into seat, as damage to needle and/or seat may result.



72281

a - Idle Mixture Needle

2. If new or rebuilt carburetor has been installed, turn idle mixture needle in (clockwise) until it lightly contacts seat, then back out needle 1-1/4 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠ WARNING

DO NOT leave the helm unattended while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable barrel from anchor stud. Be sure not to lose spacer on anchor stud.
6. Adjust idle speed adjustment screw to obtain 550-600 RPM, in neutral gear.

7. With engine running at specified RPM, adjust idle mixture needle as follows:
   a. Turn idle mixture needle in (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw out (counterclockwise) until the speed begins to drop due to rich mixture.
   c. Turn screw in to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Readjust idle speed adjustment screw until engine idles at 650-700 RPM in forward gear.

IMPORTANT: Refer to Section 2 - "Removal and Installation" for throttle cable installation and adjustment.

Repair

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove ventilation hose from flame arrestor, then remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove fuel line from fuel inlet nut, using wrench to stabilize fuel inlet nut.
5. Remove fuel pump sight tube from carburetor.
6. Disconnect electric choke.
7. Remove carburetor attaching nuts and washers and remove carburetor.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

8. Remove and discard gaskets.

Installation

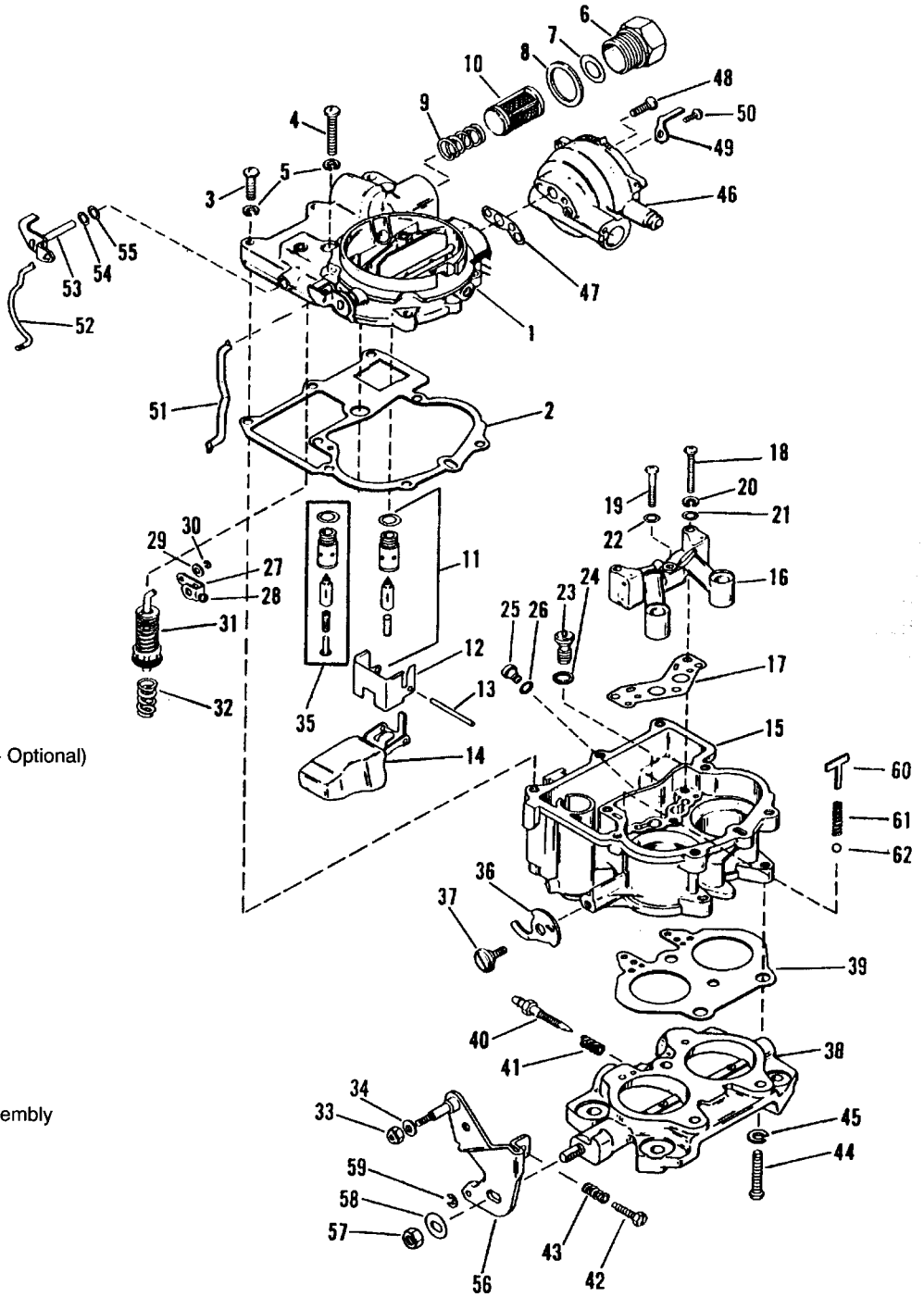
1. Thoroughly clean gasket surfaces.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to 132 lb. in. (15 N•m).
3. If fuel inlet filter nut was disturbed, remove; clean all threads with brush and carburetor cleaner or Quicksilver Leveler.
4. Connect fuel line to fuel inlet filter nut, and while stabilizing filter nut with wrench, tighten fuel line fitting securely.
5. Connect fuel pump sight tube to fitting on carburetor.
6. Connect electric choke wires to choke cover.
7. Install throttle cable as explained in Section 2.
8. Install flame arrestor and crankcase ventilation hose.
9. Reconnect battery cables to battery.
10. Ensure that water is supplied to cooling system. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
11. Adjust idle speed and idle mixture, as outlined under "Adjustments" as previously outlined.

Disassembly

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

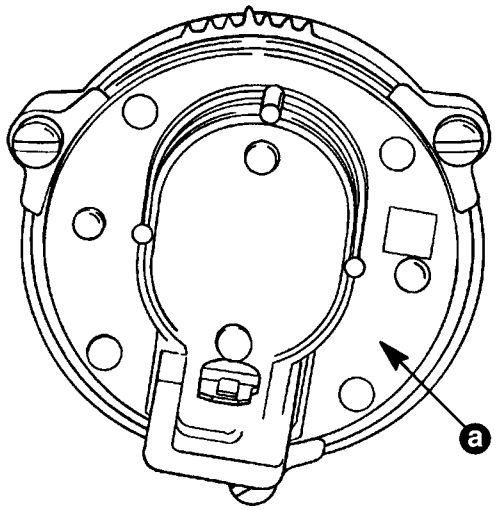
IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

1 - Air Horn
2 - Gasket
3 - Screw
4 - Screw
5 - Lockwasher
6 - Nut - Fuel Inlet
7 - Gasket
8 - Gasket
9 - Spring
10 - Filter
11 - Inlet Needle and Seat (Solid)
12 - Baffle Plate
13 - Pin
14 - Float
15 - Float Bowl
16 - Venturi Cluster
17 - Gasket
18 - Screw
19 - Screw
20 - Lockwasher
21 - Flat Washer
22 - Gasket
23 - Power Valve Assembly
24 - Gasket
25 - Jet
26 - Gasket
27 - Pump Shaft and Lever Assembly
28 - Screw
29 - Washer
30 - Clip - Retainer
31 - Accelerator Pump Assembly
32 - Spring
33 - Nut
34 - Spring Washer
35 - Inlet Needle and Seat (Spring Loaded - Optional)
36 - Cam - Idle
37 - Screw
38 - Throttle Body
39 - Gasket
40 - Idle Mixture Adjusting Needle
41 - Spring
42 - Screw - Idle Speed Adjustment
43 - Spring
44 - Screw
45 - Lockwasher
46 - Choke/Housing
47 - Gasket
48 - Screw
49 - Lever Assembly
50 - Screw
51 - Rod - Choke
52 - Rod - Accelerator Pump
53 - Accelerator Pump Shaft and Lever Assembly
54 - Washer (Outer)
55 - Washer (Inner)
56 - Throttle Lever
57 - Nut
58 - Washer - Locking
59 - Clip - Pump Rod
60 - Retainer
61 - Spring
62 - Check Ball



CHOKE HOUSING ASSEMBLY

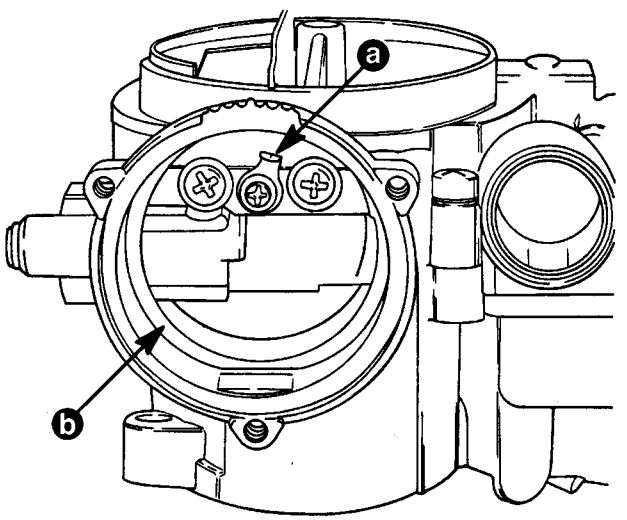
1. Remove choke cover.



72403

a - Choke Cover

2. Remove choke lever. Remove choke housing.



72401

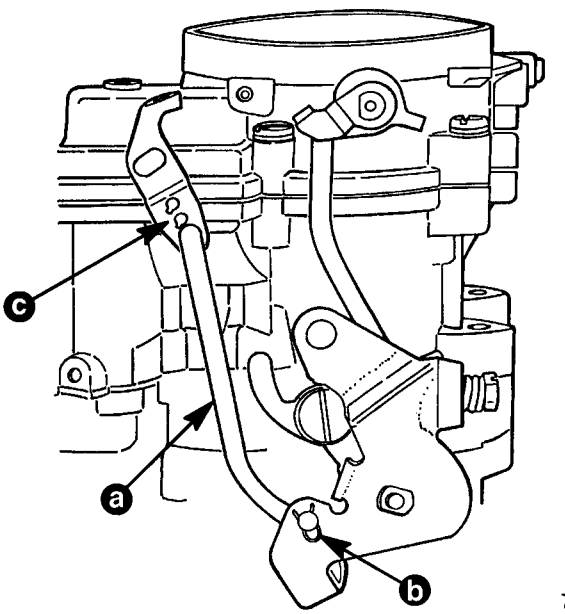
a - Choke Lever
b - Choke Housing

AIR HORN ASSEMBLY

1. Remove fuel inlet filter nut, washers, spring, and filter, as outlined previously.

IMPORTANT: Before performing the following step, make a note of the "hole location" of the pump rod in the pump shaft and lever assembly. Also, see "Adjustable Accelerator Pump Lever" information listed previously in this section.

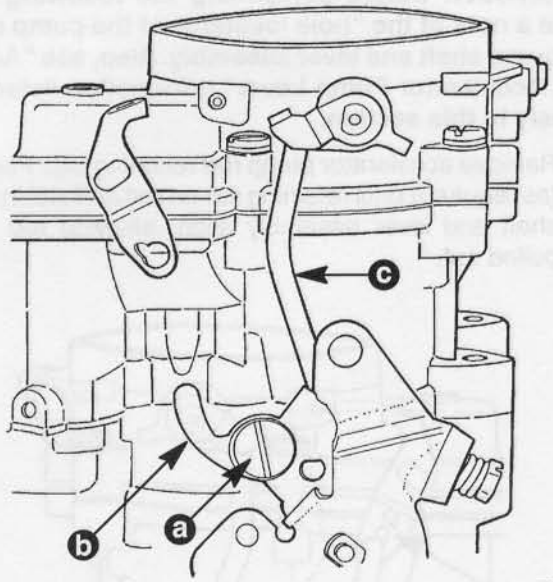
2. Remove accelerator pump rod retaining clip. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



72283

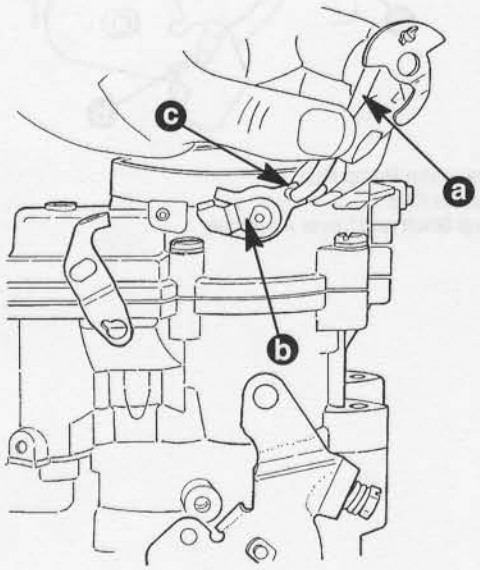
a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

3. Remove idle cam screw. Also, remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



72282

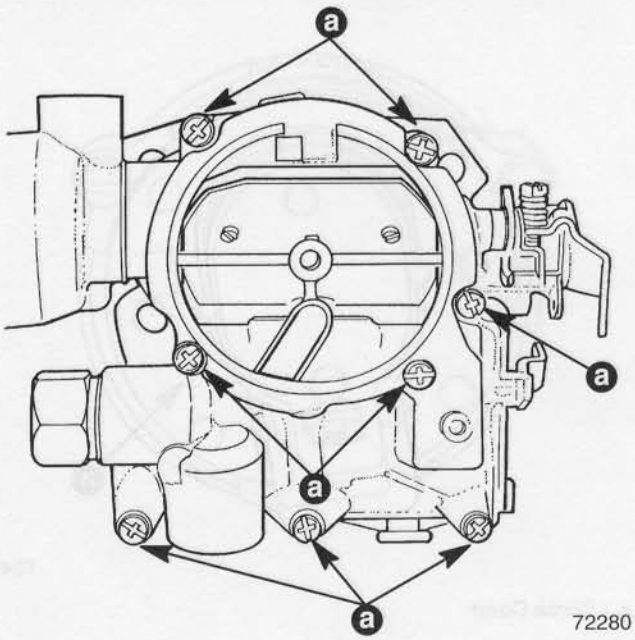
a - Idle Cam Screw
b - Idle Cam
c - Choke Rod



72286

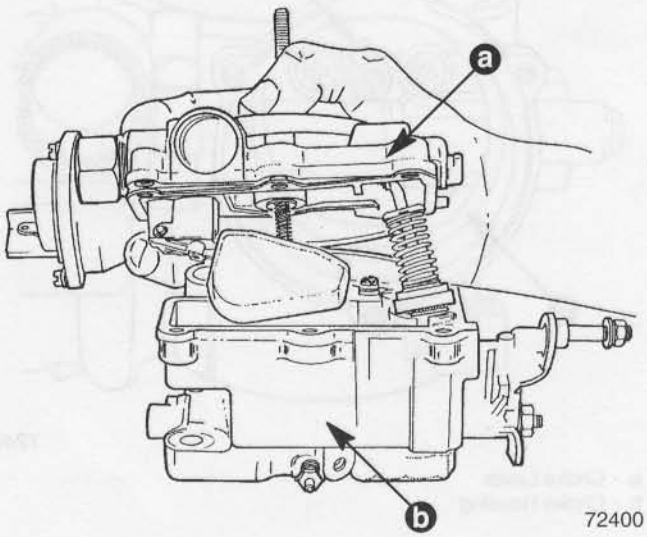
a - Choke Rod
b - Choke Lever
c - Slot

4. Remove air horn attaching screws as shown. Carefully lift air horn from float bowl assembly.



72280

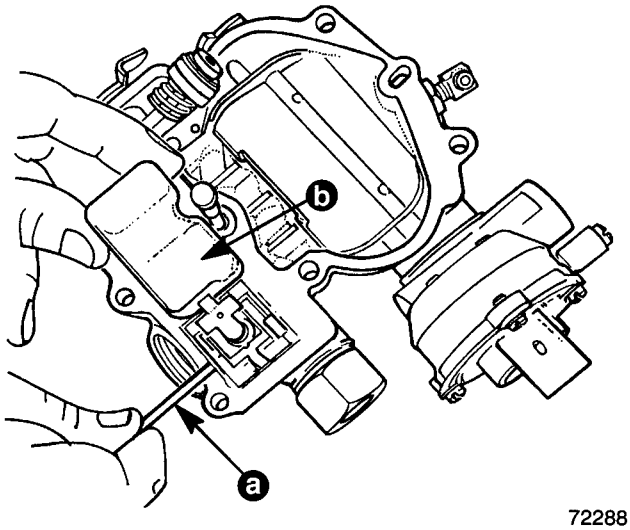
a - Air Horn Attaching Screws



72400

a - Air Horn Assembly
b - Float Bowl Assembly

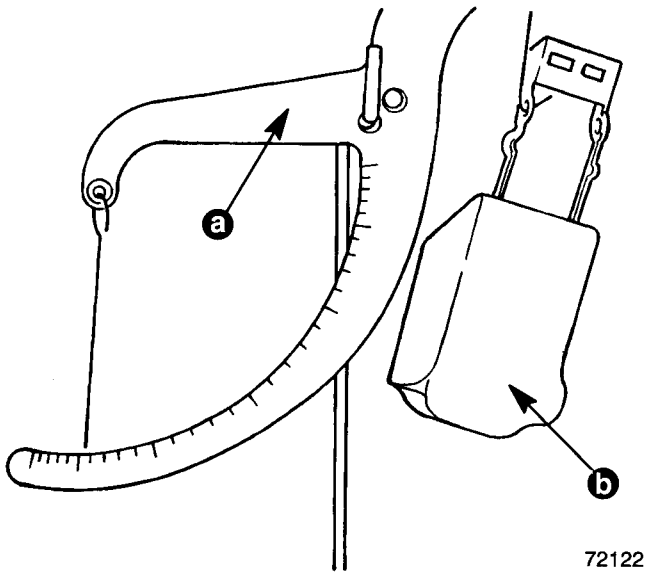
5. Invert air horn and carefully lay on bench.
6. Remove float hinge pin and lift float assembly from air horn.



72288

a - Float Hinge Pin
b - Float Assembly

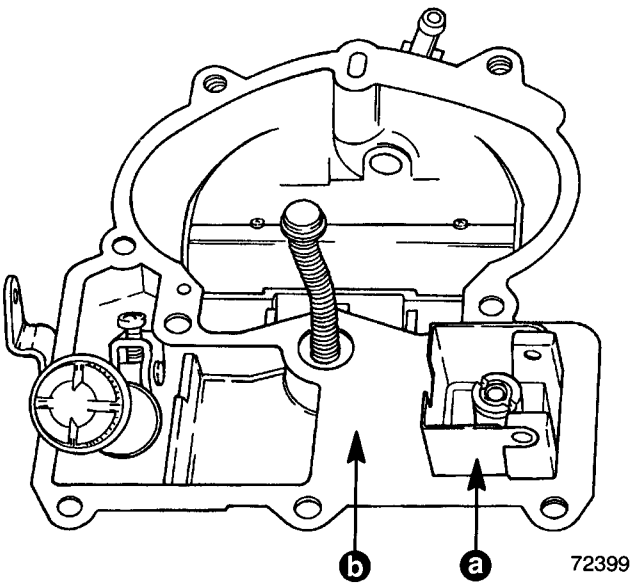
7. Check float weight as shown.



72122

a - Grams Scale
b - Float

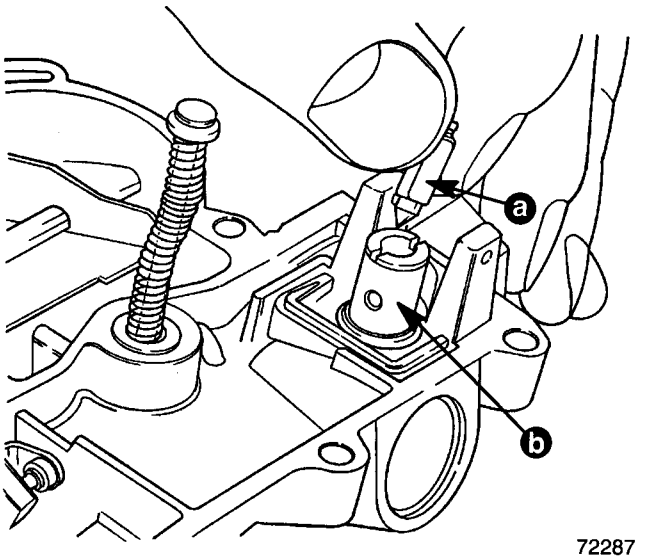
8. Remove air horn gasket and baffle.



72399

a - Baffle
b - Air Horn Gasket

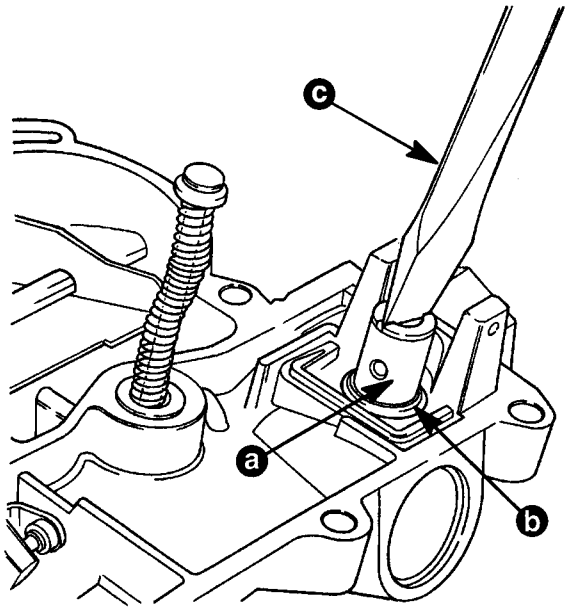
9. Remove needle assembly.



72287

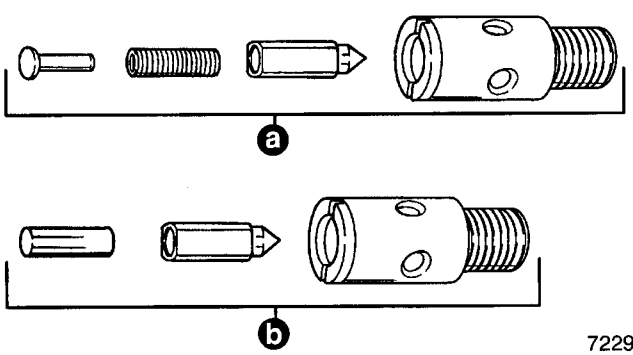
a - Needle Assembly
b - Needle Seat

10. Remove needle seat.



72289

a - Needle Seat
b - Gasket
c - Screwdriver

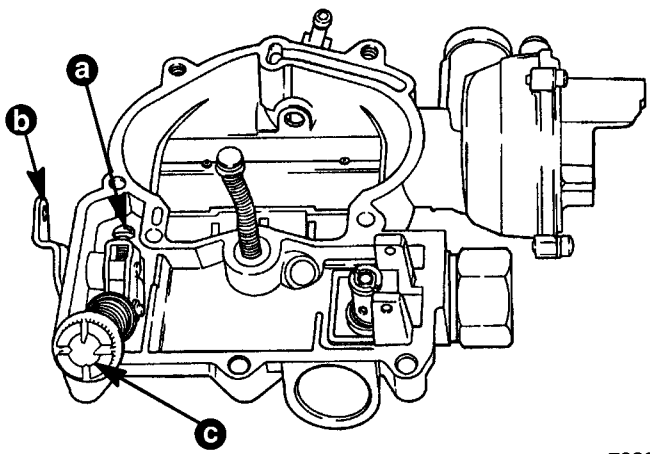


72290

a - Spring Loaded Type Needle (Kit P/N 3302-9029)
b - Solid Type Needle (Kit P/N 3302-9407)

Needle and Seat Assemblies

11. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn, then remove accelerator pump assembly.

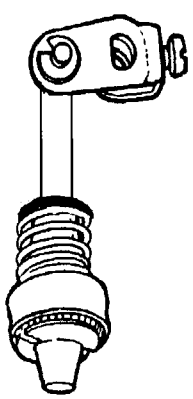


72398

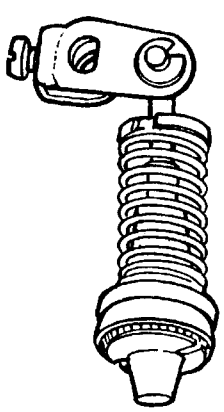
a - Setscrew
b - Lever Assembly
c - Pump Assembly

12. Remove retainer clip and washer from pump shaft and lever assembly, then remove accelerator pump assembly.

2cc Accelerator Pump



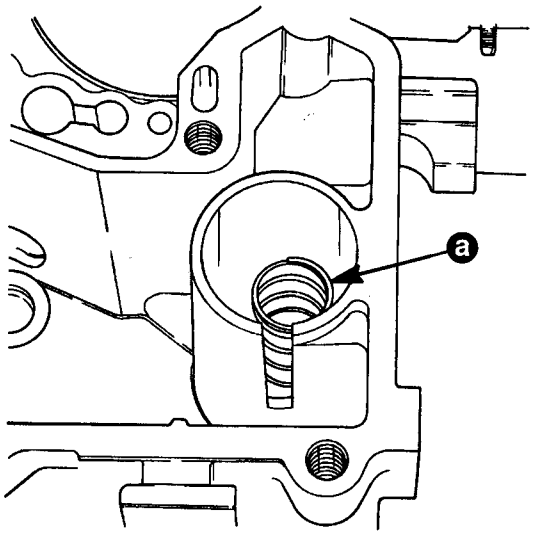
4cc Accelerator Pump



72409

FLOAT BOWL ASSEMBLY

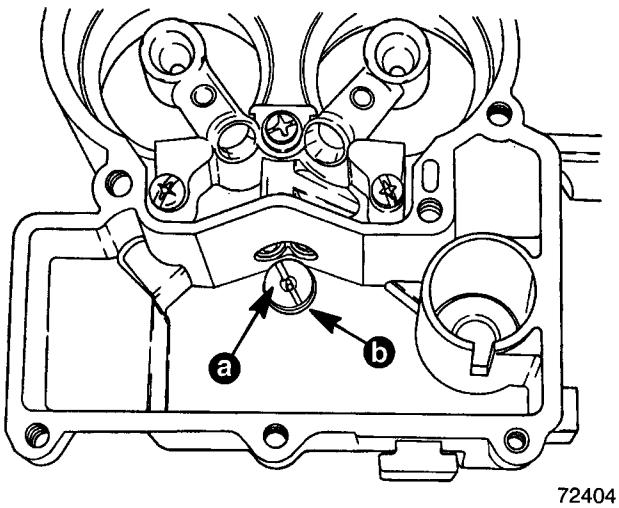
1. Remove accelerator pump return spring from pump well.



72402

a - Accelerator Pump Spring

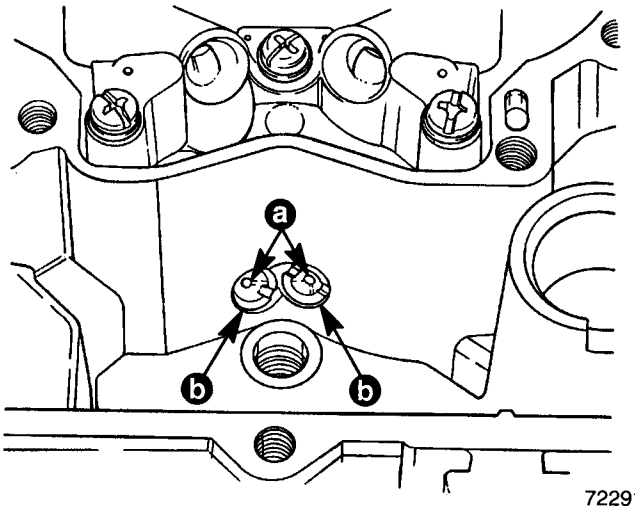
2. Remove power valve assembly and gasket.



72404

a - Power Valve Assembly
b - Gasket (Not Shown)

3. Remove main metering jets.

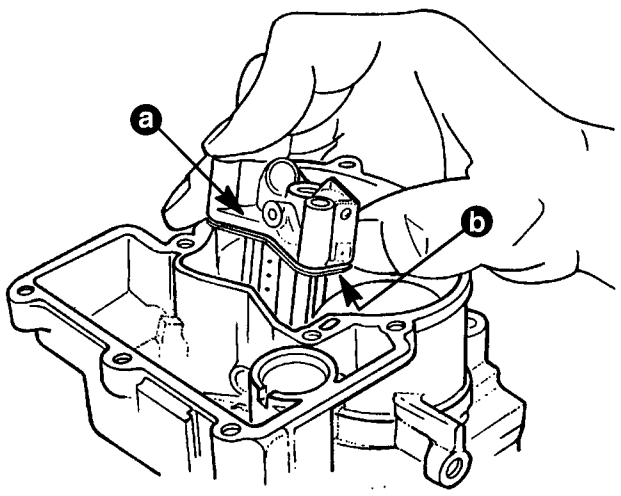


72291

a - Main Metering Jets
b - Gaskets (Not Shown)

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes which protrude from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

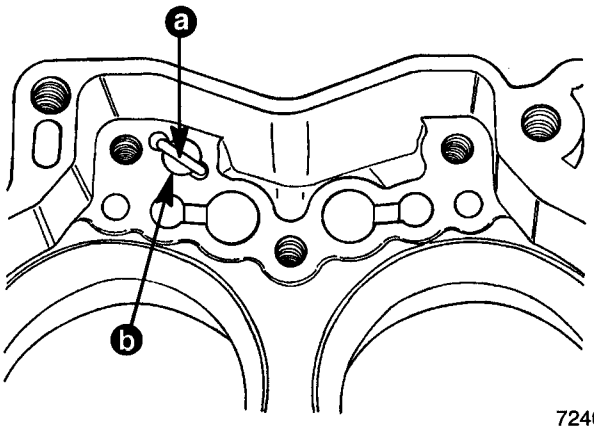
4. Remove three venturi cluster screws, and carefully lift cluster and venturi gasket straight up.



72292

a - Venturi Cluster Brass Tubes
b - Gasket

5. Using a needle-nose pliers, remove accelerator pump check ball spring retainer. Turn float bowl over to remove spring and check ball.



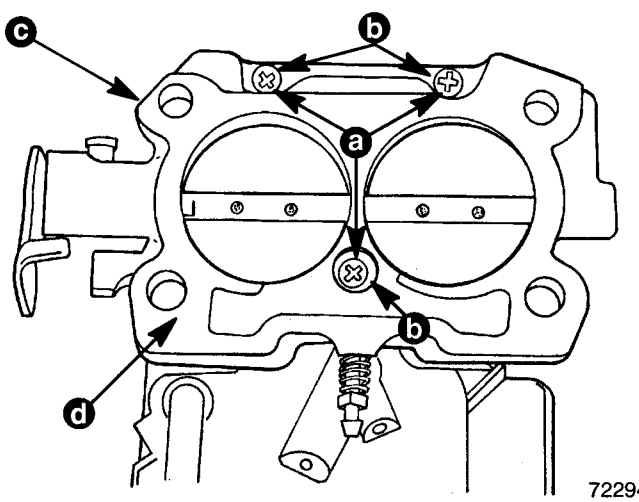
72407

a - Spring Retainer
b - Spring and Check Ball (Not Shown)

THROTTLE BODY ASSEMBLY

IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

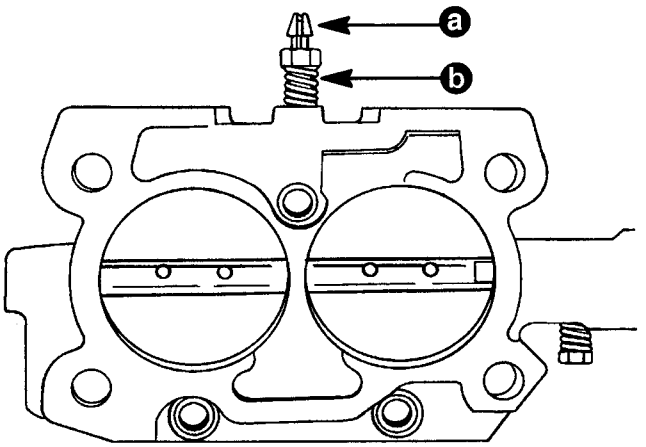
1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl.



72294

a - Screws
b - Lockwashers (Not Shown)
c - Throttle Body
d - Gasket (Not Shown)

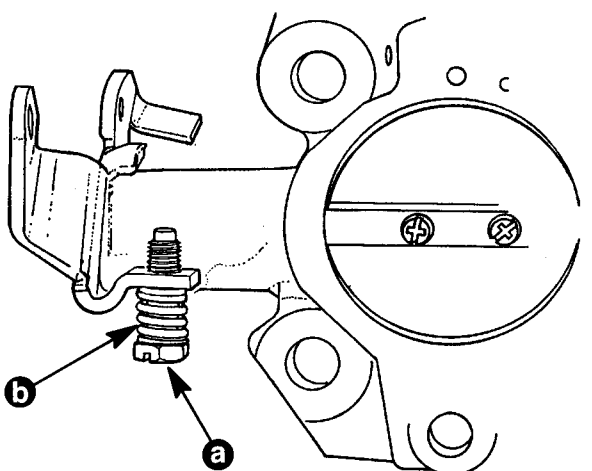
2. Remove idle mixture adjusting needle and spring.



72293

a - Idle Mixture Adjusting Needle
b - Spring

3. Remove idle speed adjustment screw and spring, if replacement is necessary.



72395

a - Idle Speed Screw
b - Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

Cleaning and Inspection

IMPORTANT: DO NOT use a wire or drill to clean jet passages or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

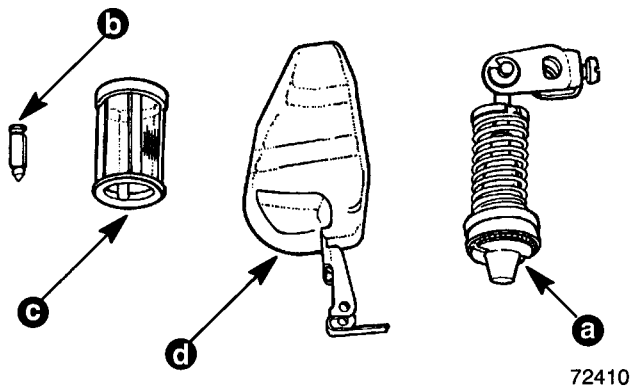
⚠CAUTION

To avoid damage to carburetor DO NOT leave carburetor in immersion type carburetor cleaner for more than two hours.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



72410

a - Accelerator Pump Plunger
b - Float Needle
c - Fuel Filter
d - Float Assembly

⚠WARNING

Avoid personal injury by always wearing safety goggles when using compressed air.

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:

   a. **Float Needle and Seat**: If float needle or seat is worn or damaged, replace with new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check float density (to see if it is saturated with fuel) by comparing weight of float with specifications. If weight is high, float assembly must be replaced. Check hinge pin and holes for wear.

   c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.

   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.

   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.

   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.

   g. **Levers and Linkages:** Check levers, links and rods for wear.

   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding through entire operating range, making sure valve opens and closes completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.

   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding through entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.

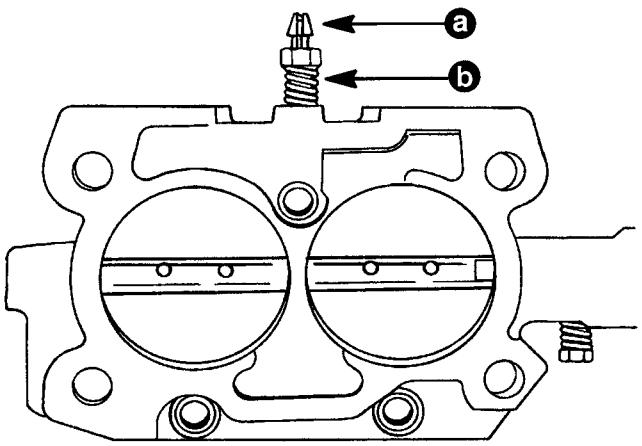
   j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

Reassembly

THROTTLE BODY ASSEMBLY

IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.

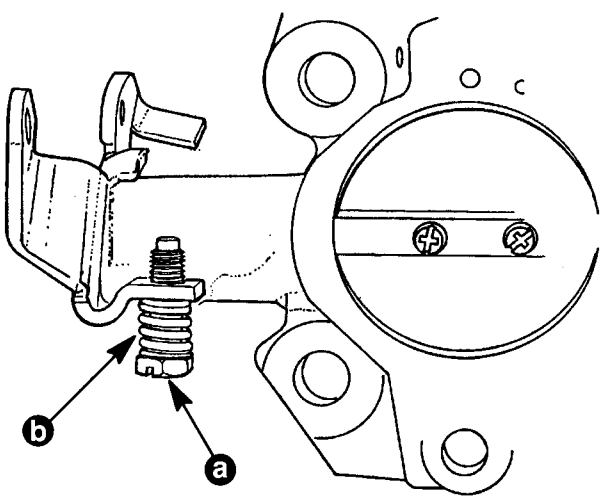
1. Screw idle mixture needle (and spring) into throttle body until they lightly seat, then back out needle 1-1/4 turns as a preliminary idle mixture setting. Final adjustment will be made with engine running. Refer to "Adjustments."



72293

a - Idle Mixture Adjusting Needle
b - Spring

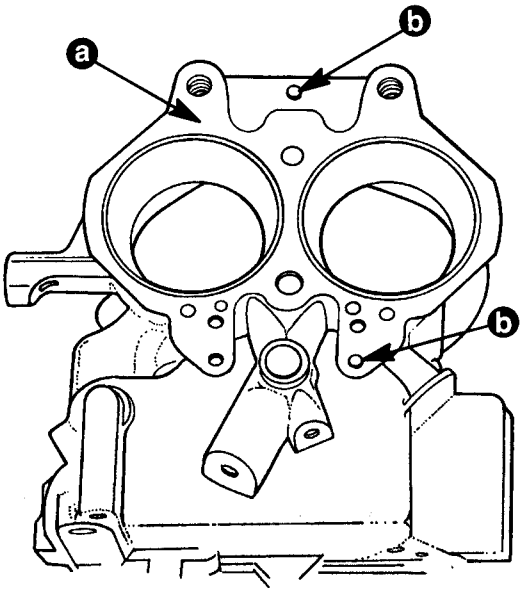
2. Thread idle speed adjustment screw and spring into throttle lever.



72395

a - Idle Speed Screw
b - Spring

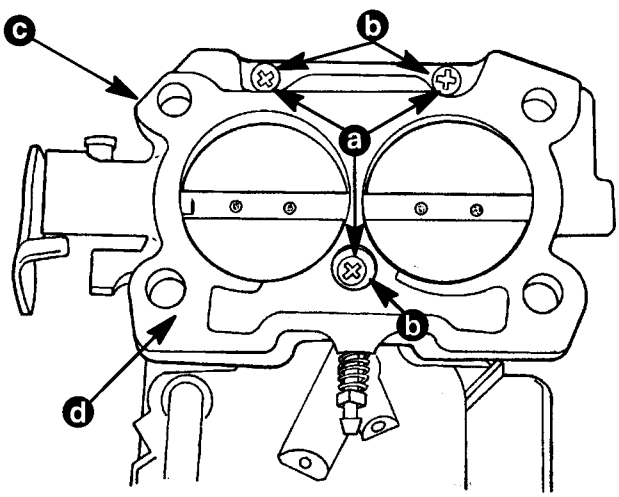
3. Turn float bowl assembly upside down and place new throttle body gasket on bowl, making sure gasket is properly positioned on location dowels.



72295

a - Throttle Body Gasket
b - Locating Dowels

4. Install throttle body assembly on float bowl assembly, making sure that screw holes in gasket line up with screw holes in throttle body. Tighten screws evenly and securely.



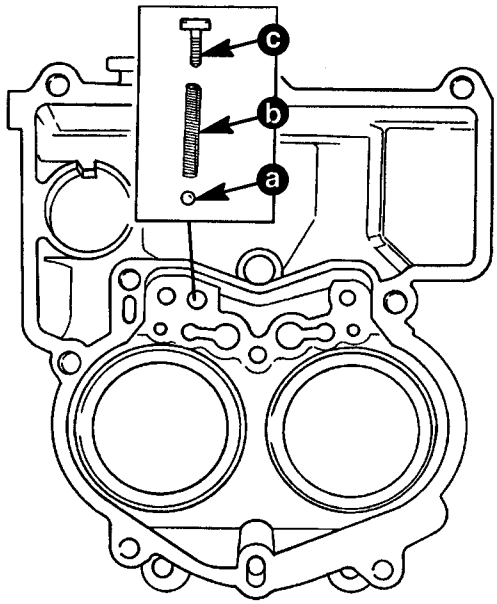
72294

a - Screws
b - Lockwashers (Not Shown)
c - Throttle Body Assembly
d - Gasket

FLOAT BOWL ASSEMBLY

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

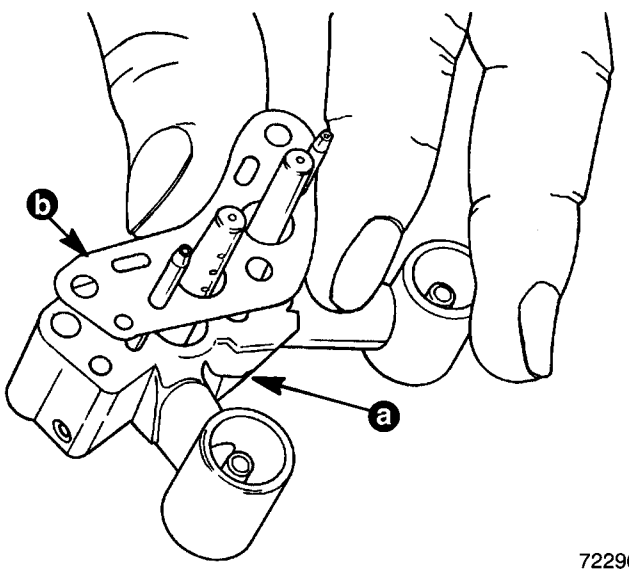
1. Install check ball, spring, and retainer in passage as shown. Push retainer firmly into slots.



72408

a - Check Ball
b - Spring
c - Retainer

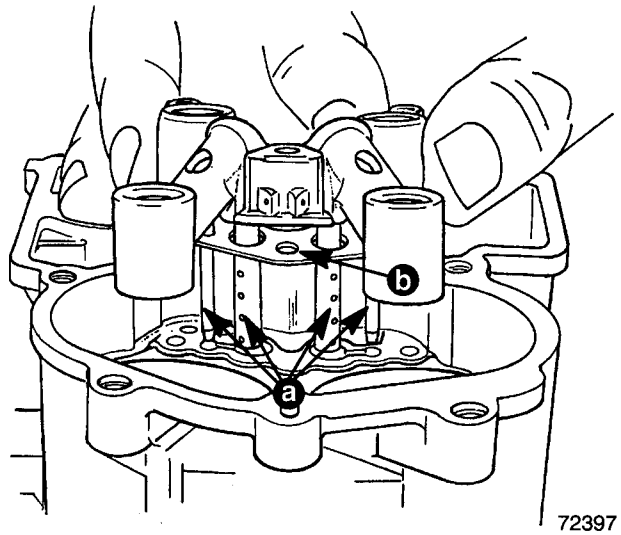
2. Install new gasket on venturi cluster as shown.



72296

a - Venturi Cluster
b - Gasket

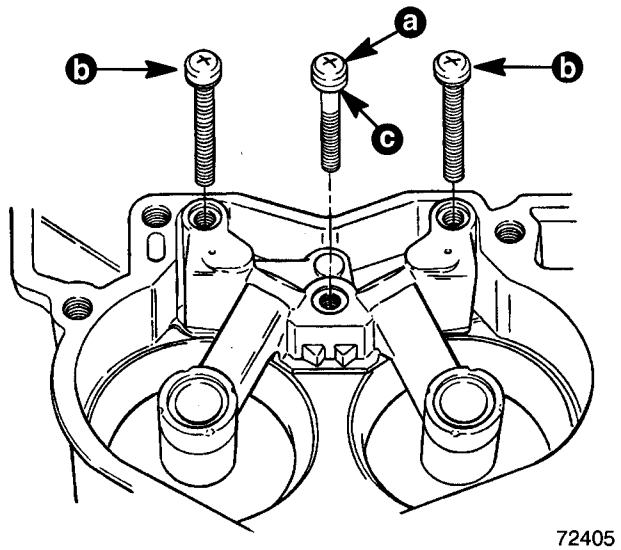
3. Install venturi cluster in carburetor as shown.



72397

a - Venturi Cluster
b - Gasket

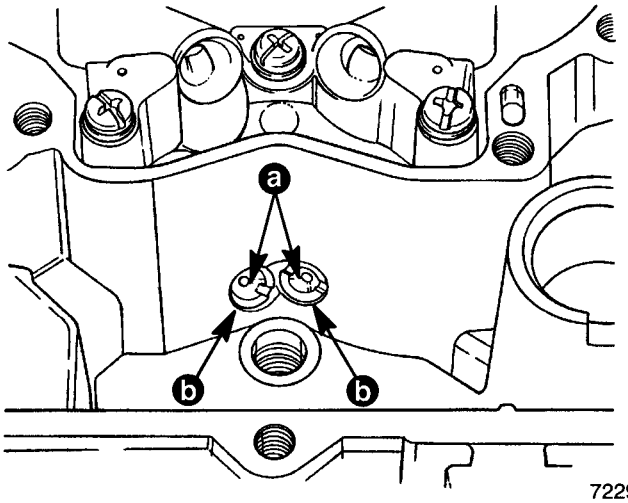
4. Install flat washer and new fiber washer on center screw. Lockwashers and flat washers are used on outer screws. Tighten screws evenly and securely.



72405

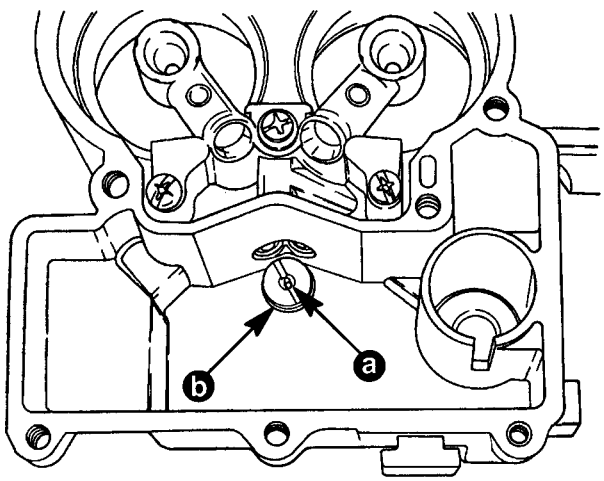
a - Center Screw
b - Outside Screws
c - Fiber Washer

5. Install main metering jets with gaskets as shown. Tighten securely.



a - Main Metering Jets
b - Gaskets (Not Shown)

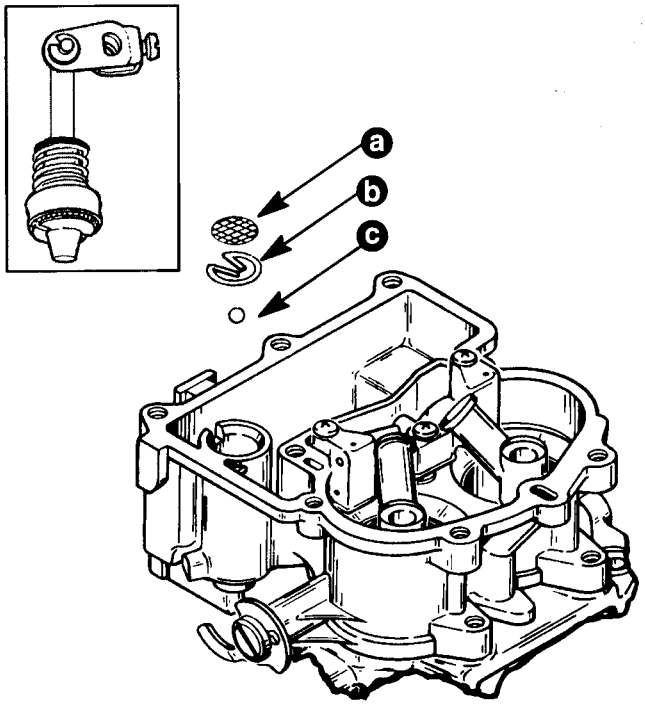
6. Install power valve with new gasket. Tighten securely.



a - Power Valve
b - Gasket (Not Shown)

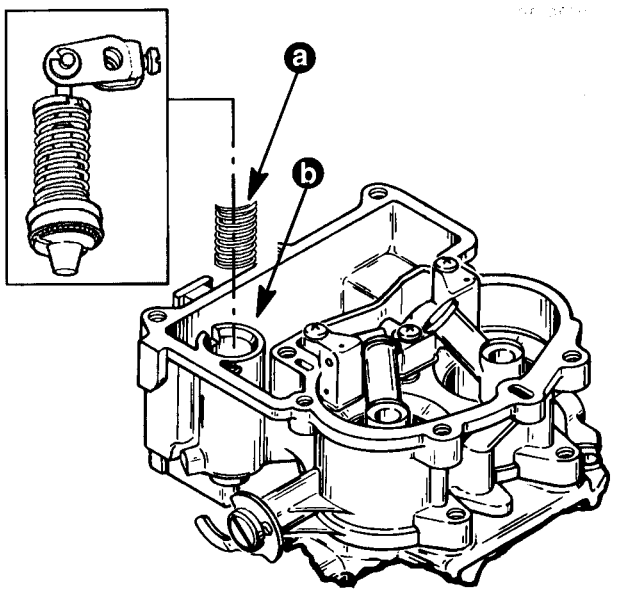
7. Place accelerator pump spring in pump well.

a. 2 cc accelerator pump



a - Strainer
b - Retainer Clip
c - Check Ball

b. 4cc accelerator pump

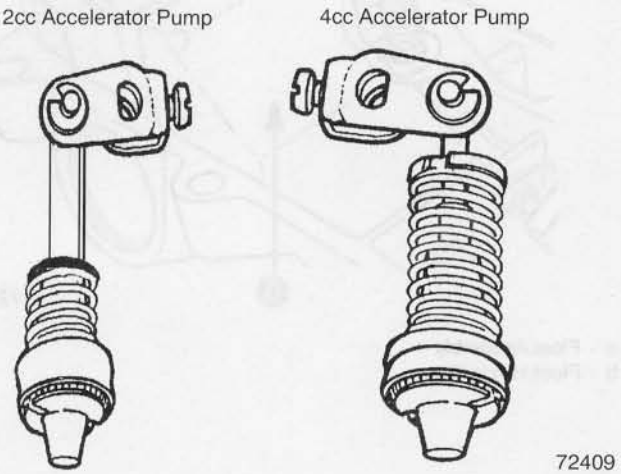


a - Accelerator Pump Spring
b - Pump Well

AIR HORN ASSEMBLY

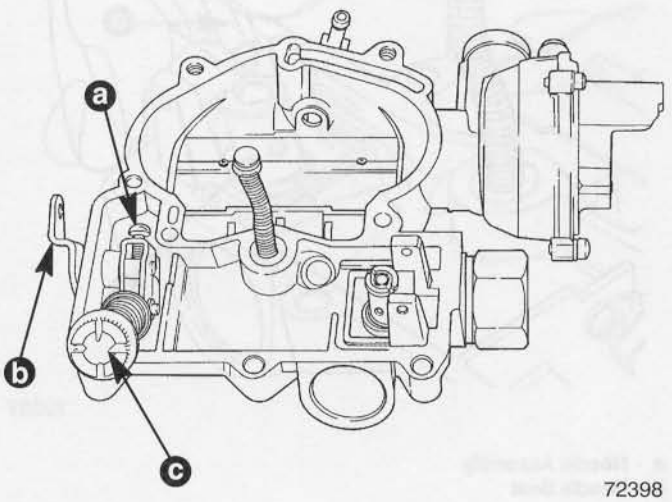
IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip, as shown.



72409

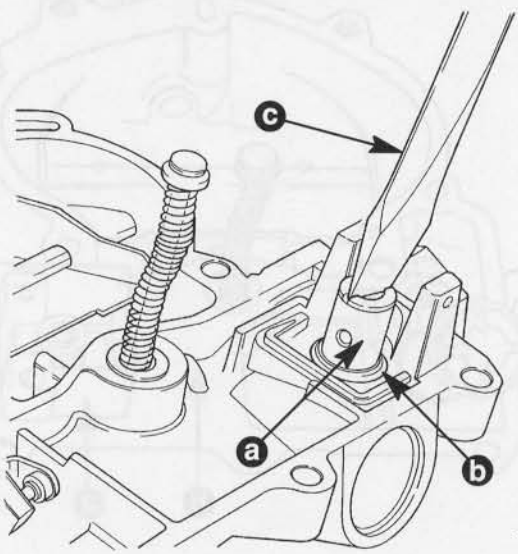
2. Insert pump shaft and lever assembly (and washer) into air horn; then, align indexed hole in pump lever with shaft and lever assembly and slide shaft all the way into lever so that shoulder on shaft is hitting lever. Tighten setscrew securely.



72398

a - Setscrew
b - Lever Assembly
c - Pump Assembly

3. Install needle seat and gasket. Tighten securely.

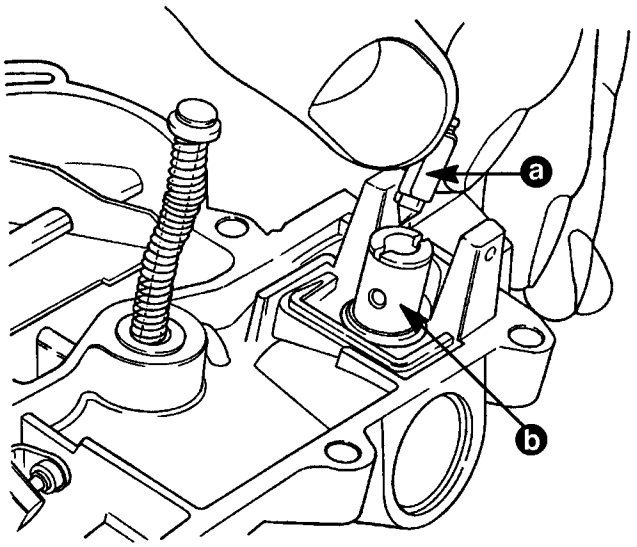


72289

a - Needle Seat
b - Gasket
c - Screwdriver

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

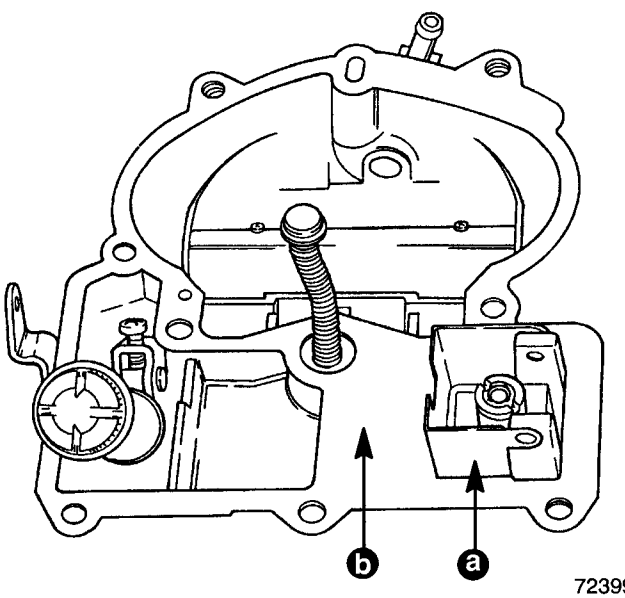
4. Place needle assembly in needle seat.



72287

a - Needle Assembly
b - Needle Seat

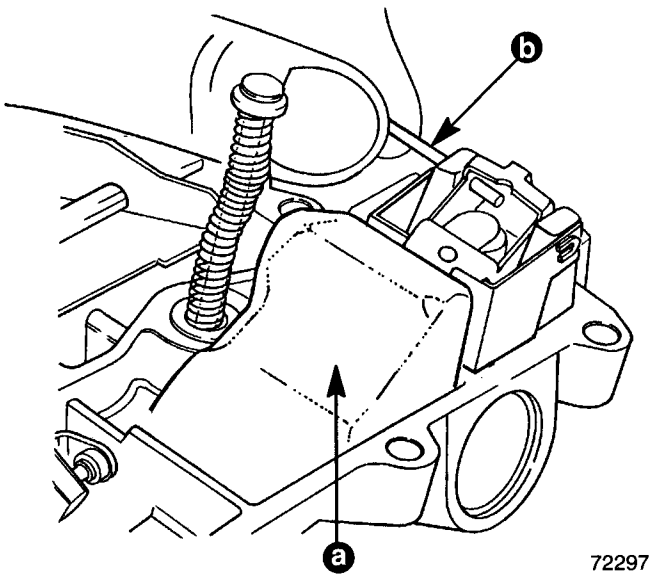
5. Install baffle and gasket.



72399

a - Baffle
b - Gasket

6. Install float assembly and hinge pin. Pivot float assembly up and down on hinge pin to ensure it moves freely.



72297

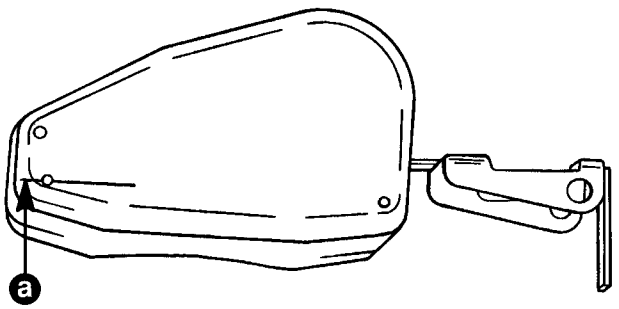
a - Float Assembly
b - Float Hinge Pin

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

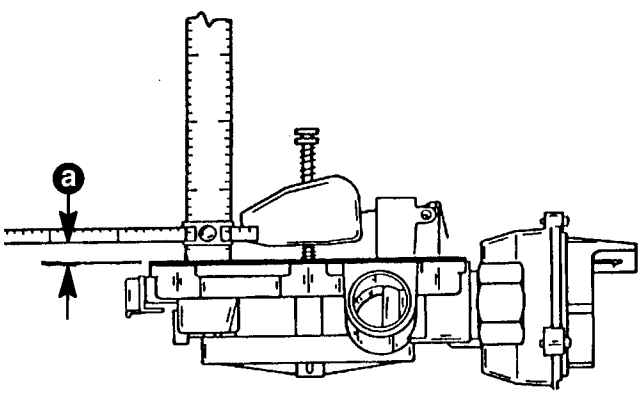
IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Measure float level using Universal Carburetor Gauge (P/N 91-36392). Measure from gasket to toe of float.



72298

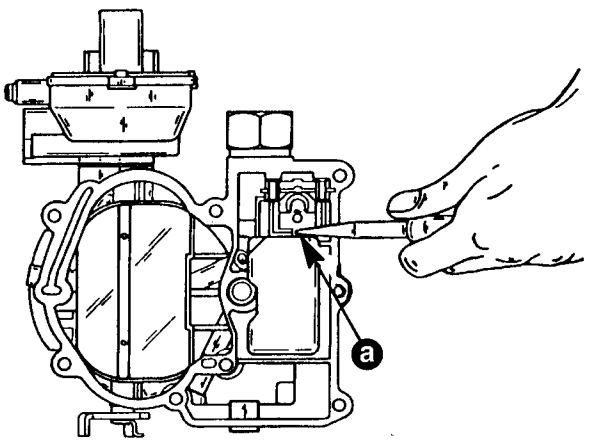
a - Measure from This Point to Gasket



72687

a - Measurement With 2 Piece Solid Inlet Needle - 3/8 in. (10 mm)
Measurement With Spring Loaded Inlet Needle - 9/16 in. (14 mm)

3. Bend float arm up or down at point shown to obtain specified dimension.



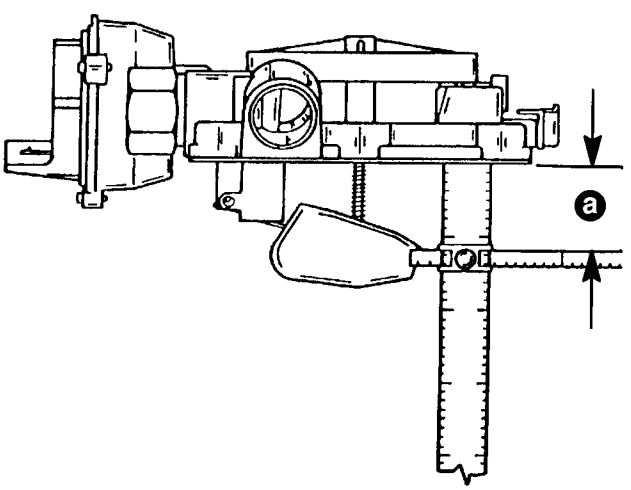
72688

a - Bend Float Arm at This Point

4. Visually check float alignment after adjustment.

FLOAT DROP

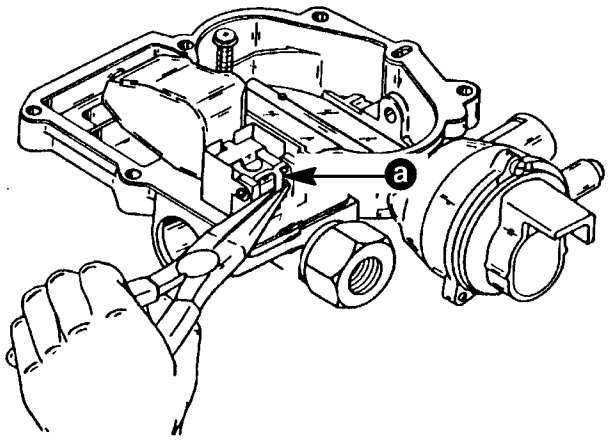
1. Hold air horn right side up to allow float to hang free.
2. Measure float drop using Universal Carburetor Gauge (P/N 91-36392). Measure from gasket to toe of float.



72689

a - Measurement - 1-1/4 in. (44.5 mm)

3. Bend float assembly tang, as shown, to obtain specified dimension.

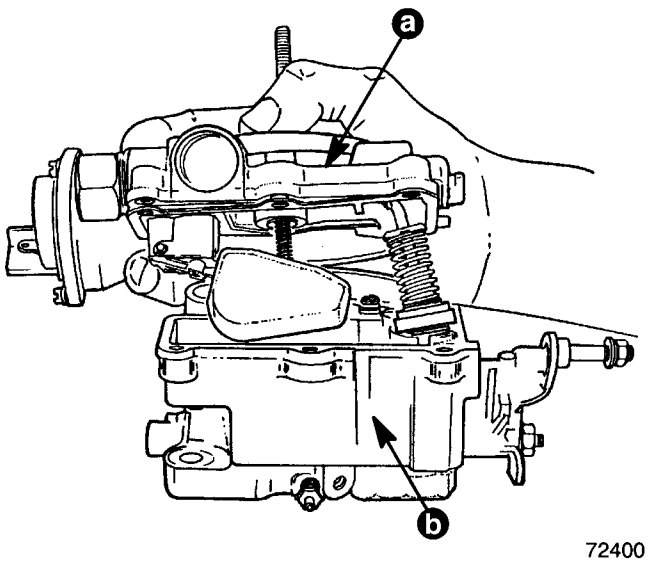


72690

a - Float Assembly Tang

4. Recheck BOTH float level and float drop.

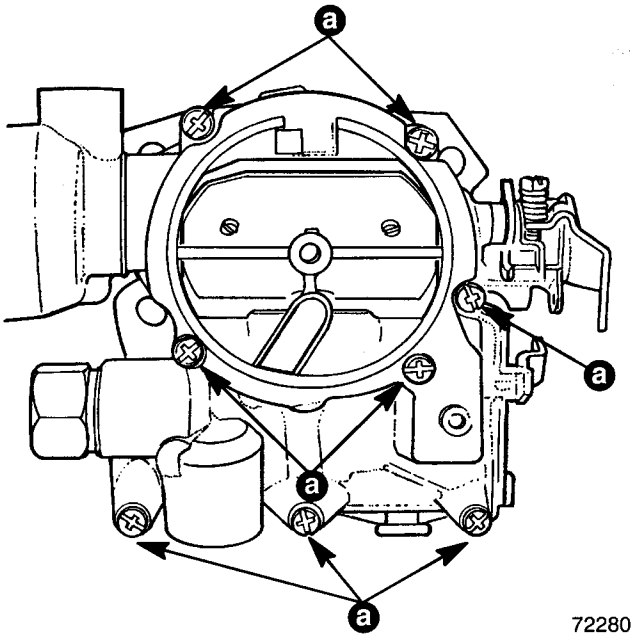
5. Carefully place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



72400

a - Air Horn Assembly
b - Float Bowl Assembly

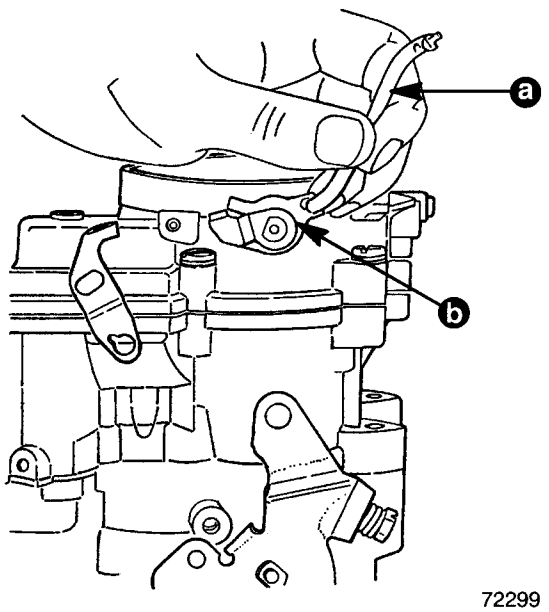
6. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely.



72280

a - Air Horn Attaching Screws

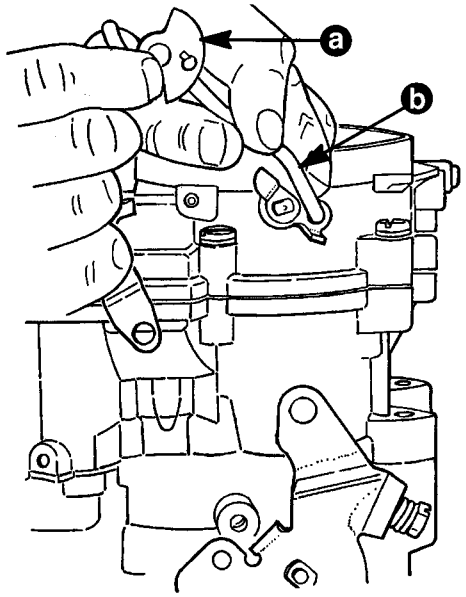
7. Place end of choke rod in choke lever and collar assembly.



72299

a - Choke Rod
b - Choke Lever and Collar Assembly

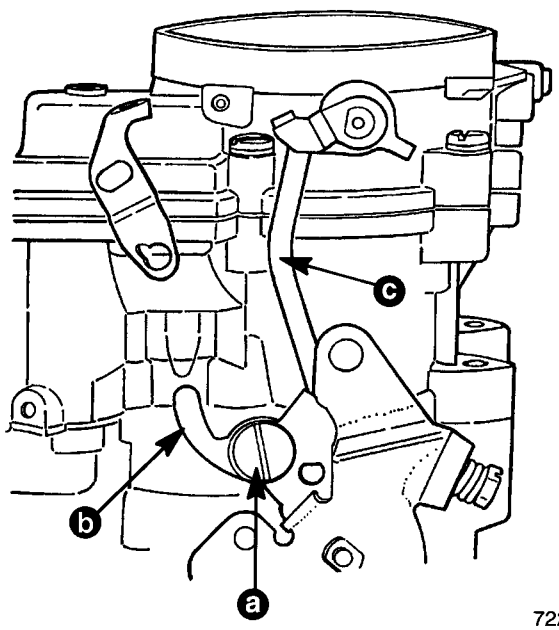
8. Place idle cam on choke rod.



72392

a - Idle Cam
b - Choke Rod

9. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. Check that cam is free to move without binding.

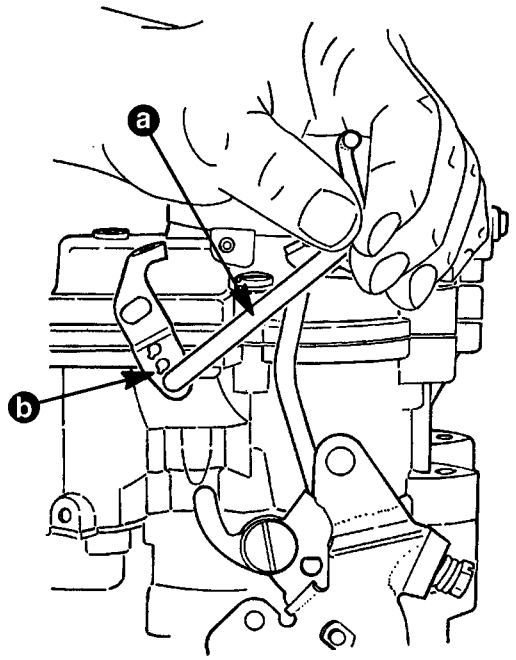


72282

a - Screw
b - Idle Cam
c - Choke Rod

IMPORTANT: Before performing the following step, see "Adjustable Accelerator Pump Lever" information listed previously in this section.

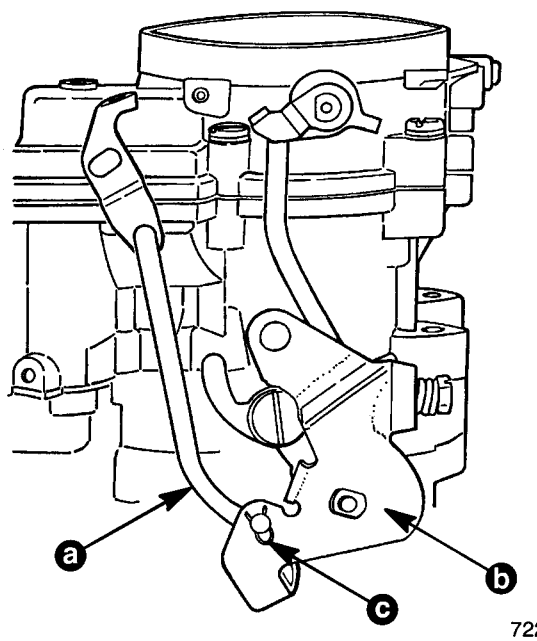
10. Place accelerator pump rod (end with ear) in appropriate hole in pump shaft and lever assembly. If adjustment was not needed, be sure that pump rod is installed in the original hole that it was removed from.



72393

a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

11. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip.

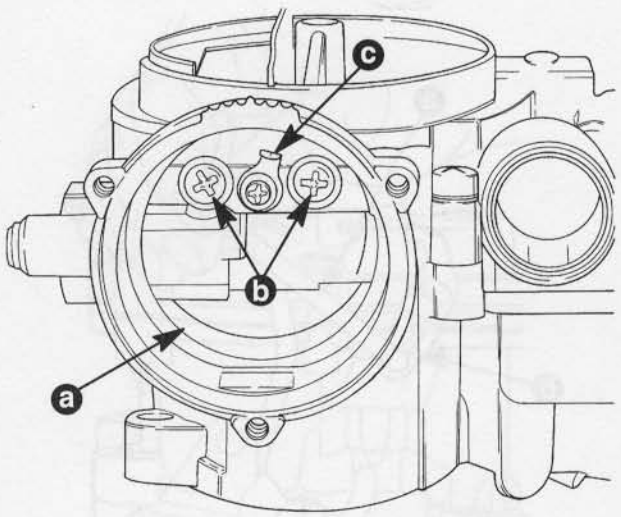


72283

a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

CHOKE HOUSING ASSEMBLY

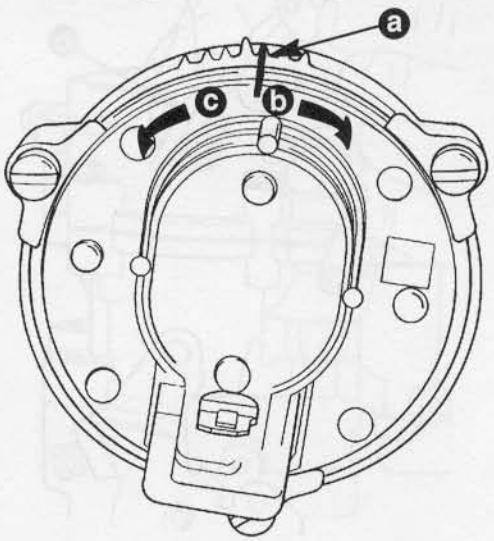
1. Install choke housing on air horn; tighten screws securely. Install choke lever; tighten screw securely.



72401

a - Choke Housing
b - Choke Housing Attaching Screws
c - Choke Lever

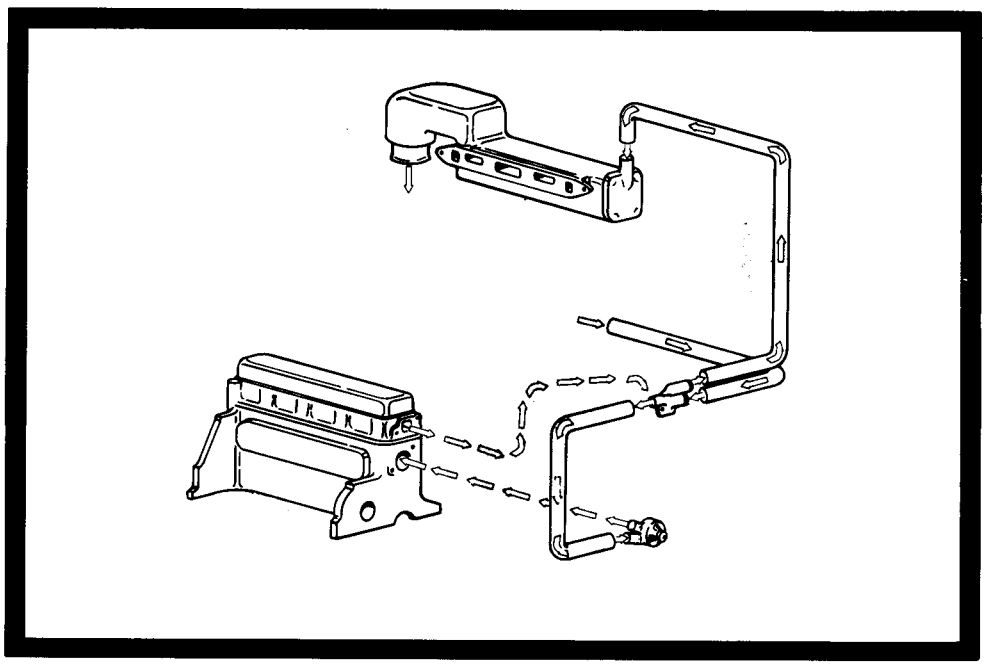
2. Install choke cover. Make sure hook on end of choke coil engages with choke lever. Rotate choke cover until index marks align as shown. Tighten screws securely.



72403

a - Scribed Mark
b - More Choke
c - Less Choke

COOLING SYSTEM



SEAWATER COOLED MODELS

6

A

mercruiser
STERN DRIVES & INBOARDS

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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)
Alternator Brace to Block	30 (41)	
Alternator to Mounting Bracket	35 (48)	
Alternator Mounting Bracket	30 (41)	
Drain Plugs (Note 1)	Securely	
Petcocks	Securely	
Power Steering Pump Brace to Block	30 (41)	
Power Steering Pump Bracket	30 (41)	
Pulleys	Securely	
Seawater Pump Brace	30 (41)	
Seawater Pump Bracket to Block	30 (41)	
Seawater Pump Clamping Screw on Cast Bracket	20 (27)	
Seawater Pump Cover		120 (14)
Seawater Pump Mounting Nuts to Stamped Steel Bracket		120 (14)
Hose Clamps	Securely	
Thermostat Cover	30 (41)	
Thermostat Housing	30 (41)	
Thru-Hull Pickup Nut	35 (42)	
Water Circulating Pump	30 (41)	
Water Temperature Sender	20 (27)	

NOTE 1: Coat threads with Quicksilver Perfect Seal before installing.

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Alternator Brace to Alternator		192 (28)
Alternator Brace to Block	30 (41)	
Alternator to Mounting Bracket	35 (48)	
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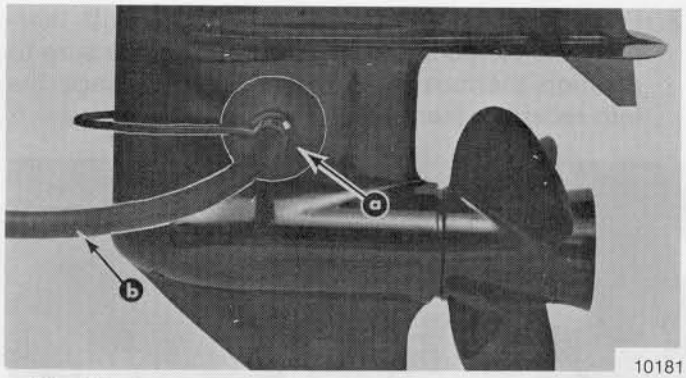
Pulleys	Securely	
Seawater Pump Brace	30 (41)	
Seawater Pump Bracket to Block	30 (41)	
Seawater Pump Clamping Screw on Cast Bracket	20 (27)	
Seawater Pump Cover		120 (14)
Seawater Pump Mounting Nuts to Stamped Steel Bracket		120 (14)
Hose Clamps	Securely	
Thermostat Cover	30 (41)	
Thermostat Housing	30 (41)	
Thru-Hull Pickup Nut	35 (42)	
Water Circulating Pump	30 (41)	
Water Temperature Sender	20 (27)	

NOTE 1: Coat threads with Quicksilver Perfect Seal before installing.

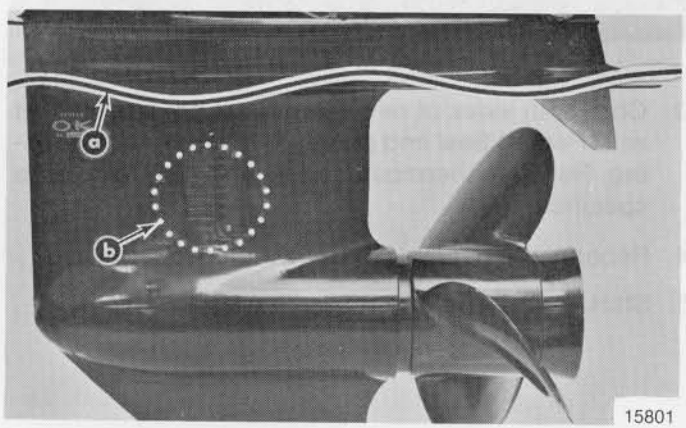
Stern Drive Unit Seawater Pickup



10181

a - Flush Device
b - Garden Hose

1. Install flush device and connect garden hose between it and water tap.
2. Saltwater areas and boat in the water:
   a. Raise stern drive unit to full trailer position.
   b. Install flush device over water intake holes.
   c. Lower stern drive unit to full down position.



15801

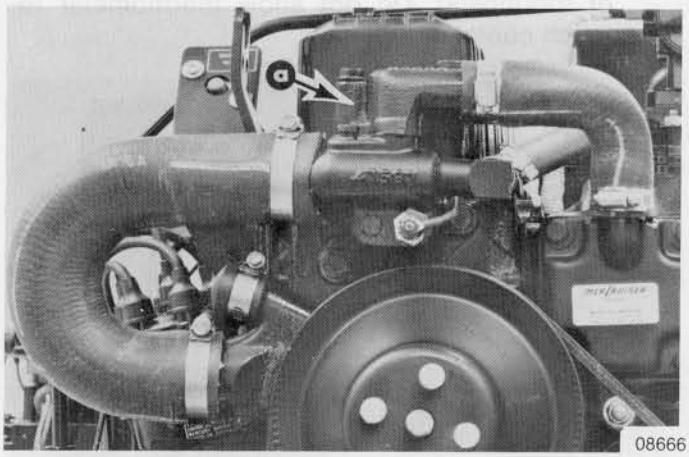
a - Minimum Water Level
b - Water Intake Holes

3. Partially open water tap (approx. 1/2 maximum capacity) and allow cooling system to fill completely. Do not use full water tap pressure.
4. Place remote control in neutral position and start engine. Watch temperature gauge to ensure that engine does not overheat.
5. Stop engine, turn off water tap and remove flush device.

Thermostat

Removal

1. Drain water from cylinder block and exhaust manifold(s).
2. Disconnect hose(s) from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing or cover.



08666

a - Thermostat Cover

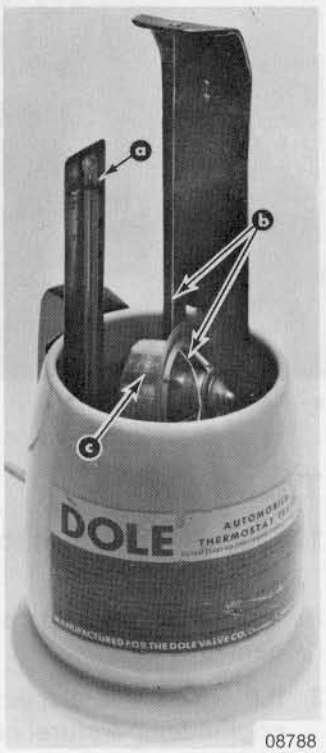
Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or 2 points around the valve perimeter is acceptable.)

11363

a - Check for Light Leakage around Perimeter of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:
   a. Fill tester to within 1" (25mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.



08788

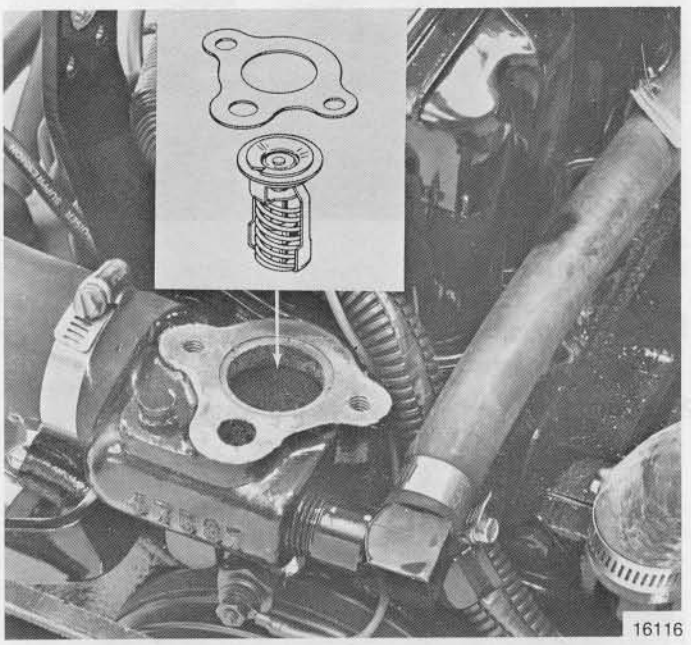
a - Thermometer
b - Nylon String
c - Thermostat

IMPORTANT: When performing Steps d-thru-f, water must be agitated throughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.
   e. Continue to heat water until a temperature 25° F (14° C) above temperature specified on thermostat is obtained. Thermostat valve must be completely open at this temperature.
   f. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   g. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Clean gasket surfaces on thermostat cover and thermostat housing.
2. Place thermostat in thermostat housing with thermostatic element end toward housing. Be sure to position thermostat so that mounting flange fits into recess in thermostat housing.


16116

3. Coat both sides of new thermostat housing gasket with Perfect Seal and position on thermostat housing. Reinstall thermostat cover and torque bolts to specifications.
4. Reconnect hose(s) to thermostat cover.
5. Start engine and inspect for leaks.

Out-of-Season Storage (Draining)

Draining Precautions

IMPORTANT: If the possibility of freezing exists, cooling system must be drained to prevent freeze damage to cooling system. Cooling system also should be drained if boat is to be stored for an extended period of time to prevent corrosion damage.

⚠CAUTION
Cooling system, must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

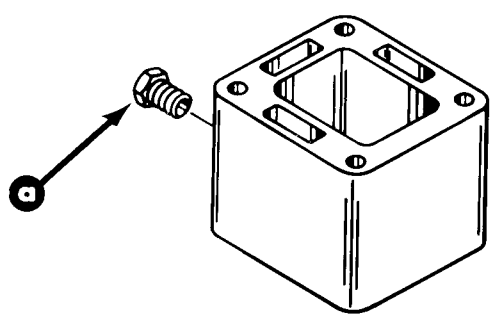
⚠CAUTION
If boat is in the water, water inlet valve (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

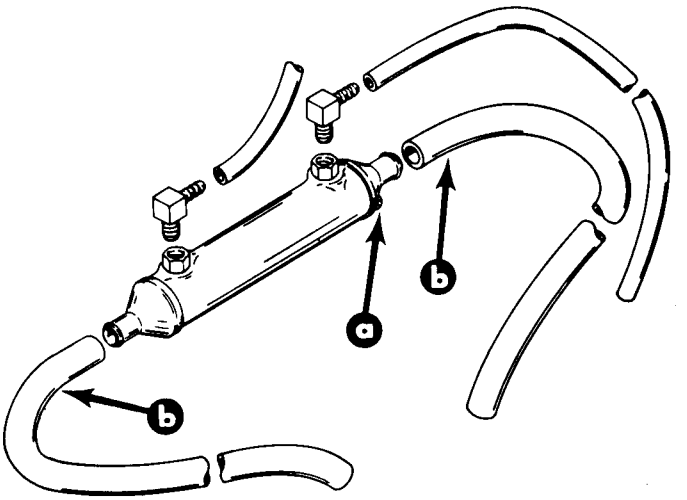
NOTE: If possible, place a container under drains to prevent water from draining into boat.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.



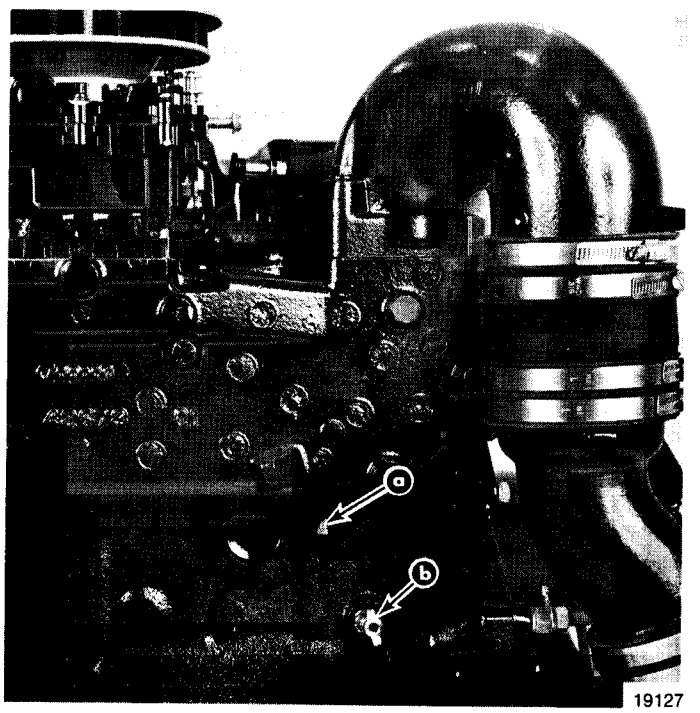
a - Drain Plug - Remove

3" or 6" Risers (If Equipped)



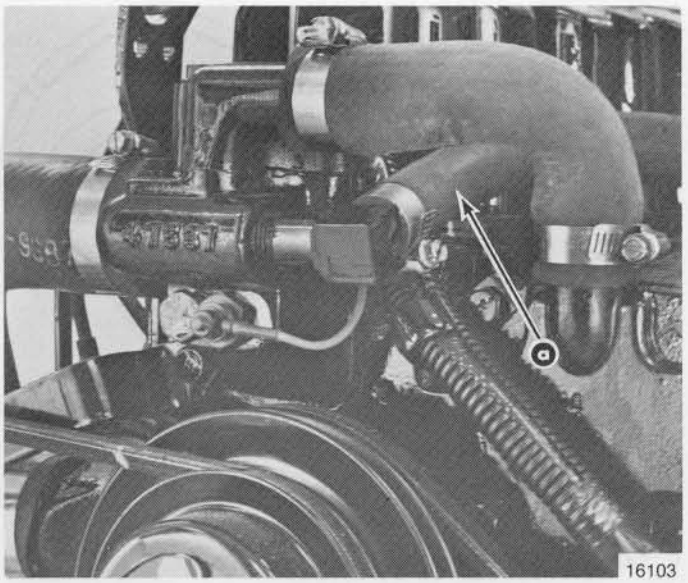
a - Drain Plug - Remove
b - Cooler Without Drain Plug - Remove Hoses

Power Steering Fluid Cooler (If Equipped)



a - Drain Plug
b - Petcock

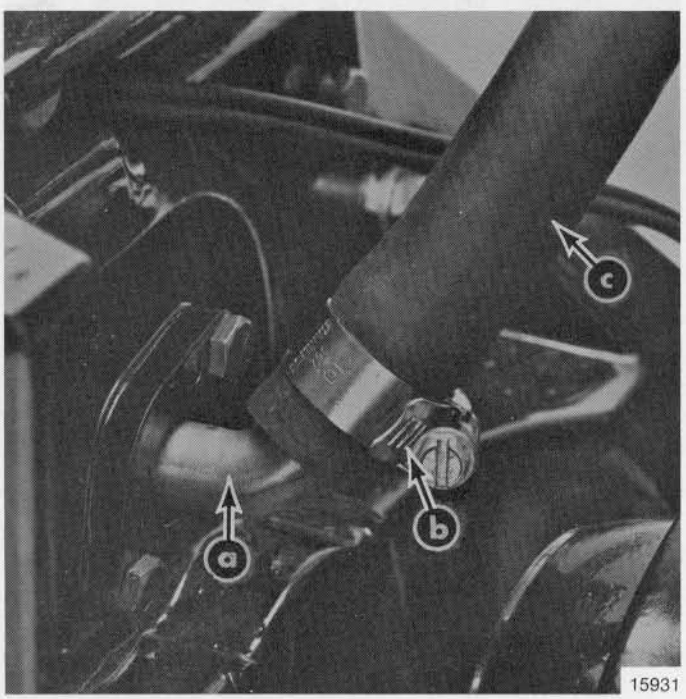
Engine Drain Location



a - Remove Hose and Lower to Drain

Draining Inlet Hose

3. **Drive Shaft Extension Models:**
   Disconnect water inlet hose from gimbal housing. Lower to drain hose (and power steering fluid cooler, if equipped).



a - Water Tube
b - Hose Clamp (Tighten Securely)
c - Water Hose

4. **Power Steering Models:** Fluid cooler will drain back thru stern drive unit.
5. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Close petcock.
6. For additional assurance against freezing and rust, fill the cooling system with a solution of permanent antifreeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage).

a - Remove Cover and Thermostat. Fill with Coolant until Block and Head are Full. Using New Gasket, Install Thermostat and Cover. Torque Screw to Specifications
b - Remove Hose. Fill Manifold with Coolant. Reinstall Hose and Tighten Clamp Securely

Auxiliary Hot Water Heater Installation

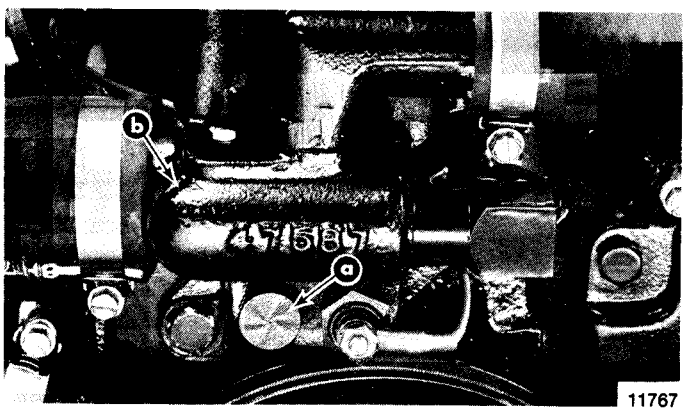
When connecting a cabin heater or hot water heater to a MerCruiser engine, certain requirements must be met.

- Supply hose (from engine to heater) and return hose (from heater to engine) must not exceed 5/8" (16mm) I.D. (Inside Diameter).
- **MerCruiser Engines Equipped with a Closed Cooling System:** Heater must be lower than the fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost in the system, an air pocket may form in the closed cooling system. This in turn, can cause the engine to overheat.
- Make heater connections to MerCruiser engines only at locations shown.
- Check complete system for leaks after heater is connected into cooling system.
- Check for overheating condition (of engine) after heater is connected into cooling system.

An Auxiliary Hot Water Heater Kit is not available from Mercury Marine, for the above model MerCruiser engines. To connect a cabin heater or hot water heater to these engines, use the following procedure.

1. Drain water from cooling system.
2. Remove plug from thermostat housing at location shown.

IMPORTANT: If thermostat housing is equipped with a 1/8" .27 NPT plug (same size as exhaust manifold drain plug), hole from which pipe plug was removed must be rethreaded to 3/8" - 18 NPT. To rethread hole, remove thermostat housing and drill out hole to 37/64" then rethread using a 3/8" - 18 NPT tap. Blow out housing with compressed air to remove metal chips and reinstall housing with a new gasket. Torque bolts to 30 lbs. ft. (41 N.m). Hole in newer style thermostat housing is threaded to 3/8" - 18 NPT and requires no modification.



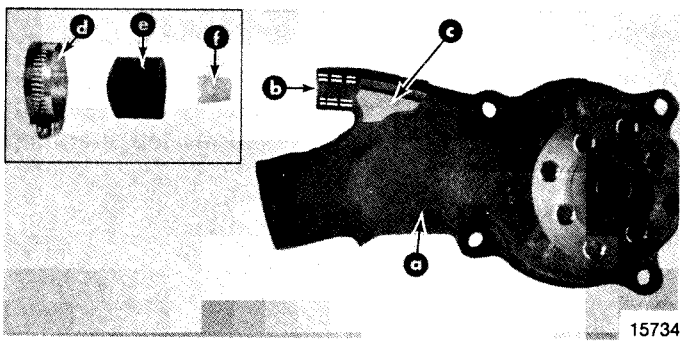
11767

a - Plug - See Important
b - Thermostat Housing

3. Coat threads on appropriate size bayonet type fitting (obtained from a local source) with Perfect Seal and install into threaded hole. Tighten fitting securely.
4. Connect hot water heater supply hose to bayonet fitting and secure with a hose clamp.
5. Drill 3/8" (10mm) hole into circulating pump on front of engine.

IMPORTANT: By using grease on drill bit and being careful during drilling, most metal chips can be caught in grease. If this cannot be done, remove circulating pump for drilling. Clean pump thoroughly with compressed air, reinstall using new gasket.

   a. On some earlier model engines, a wooden plug and rubber cap or just a rubber cap is installed on circulating pump. Remove clamp and discard these pieces.



15734

a - Circulating Pump
b - Drill 3/8" (10mm) As Shown
c - Water Chamber
d - Hose Clamp (Some Models)
e - Rubber Clamp (Some Models)
f - Wooden Plug (Some Models)

6. Connect hot water heater return hose to fitting on circulating pump and secure with hose clamps.
7. Support hoses, as required, to ensure that they do not rub or chafe against engine components.
8. With boat in the water, start engine and check for:
   a. Leaks
   b. Overheating

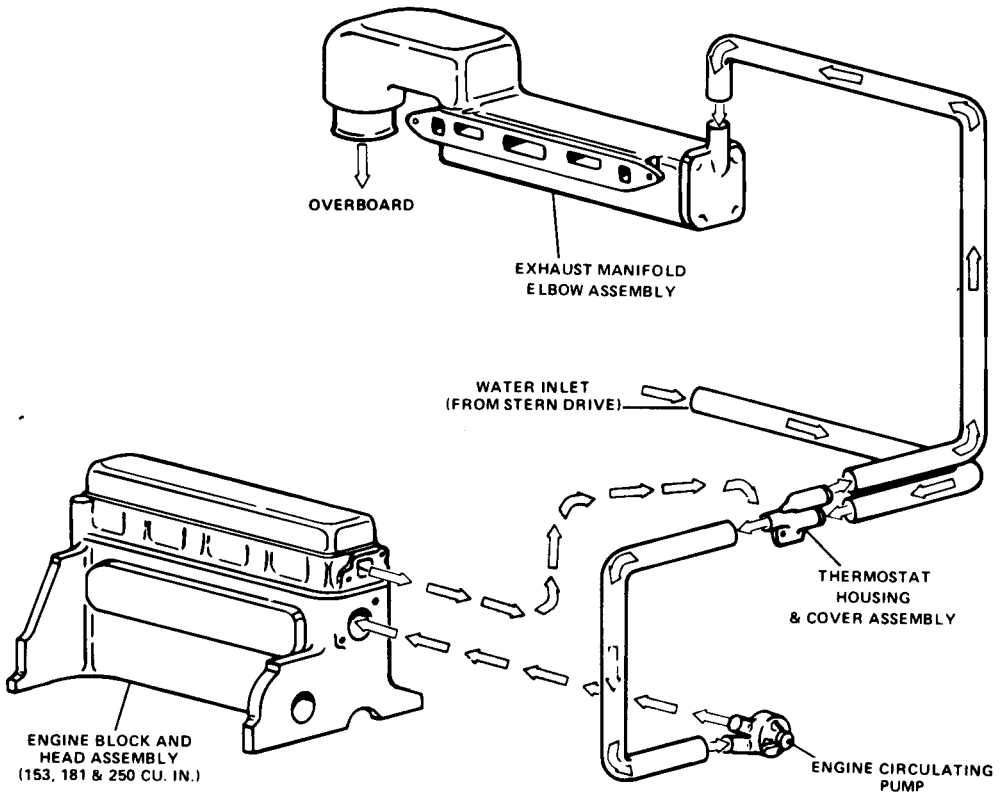
Cooling System Flow Diagrams

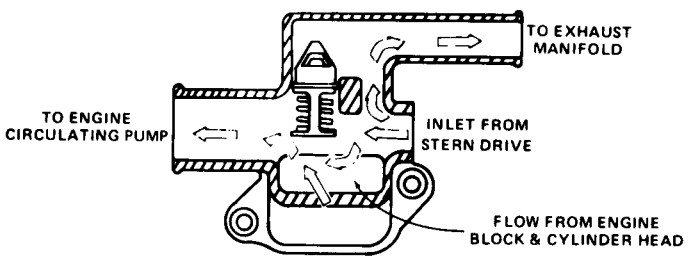
MerCruiser engines with standard cooling systems use seawater (water in which the boat is being operated) to remove the heat given off by the engine.

The seawater is pumped to the cooling system by means of an impeller type pickup pump (located in the vertical drive or belt driven at the front of engine) which picks up seawater and delivers it to the centrifugal pump (located over an opening on the front of the cylinder block). On some models, seawater may be pumped through an oil cooler before going to the circulating pump. The centrifugal pump then circulates the seawater through the block, head(s) and manifold(s), removing the heat given off by these parts as it passes.

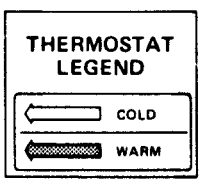
After passing through the engine, the seawater is pumped into the exhaust elbow, where it mixes with the exhaust gases, and is expelled overboard.

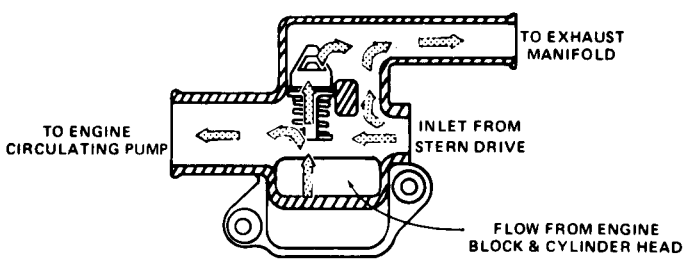
A thermostatic heat control, which controls circulation of the seawater, also is incorporated into the system. It provides fast engine warmup and controlled operating temperature.





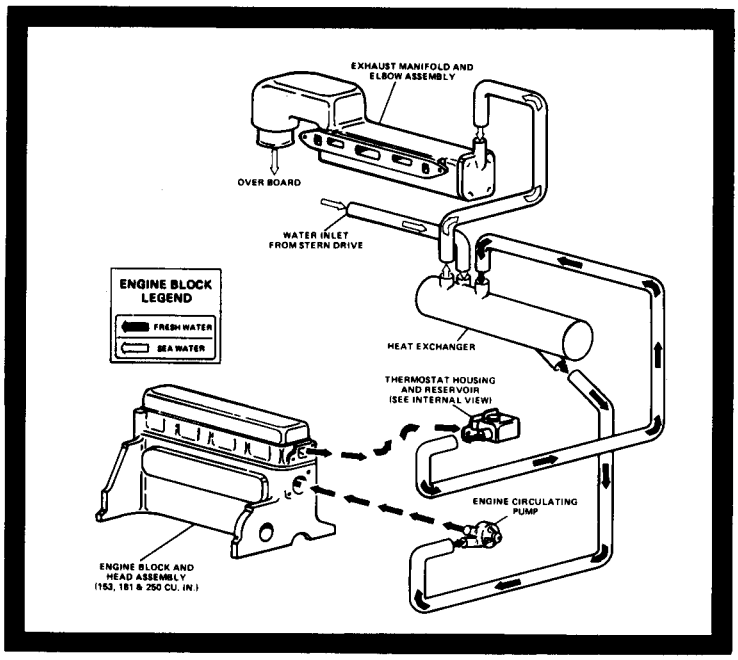
WATER FLOW THROUGH THERMOSTAT HOUSING
WITH THERMOSTAT CLOSED





WATER FLOW THROUGH THERMOSTAT HOUSING
WITH THERMOSTAT OPEN

COOLING SYSTEM



CLOSED COOLED MODELS

6

B

mercruiser
STERN DRIVES & INBOARDS

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NOTICE

Refer to Section 6, Part A for the following:

- **Stern Drive Unit Seawater Pickup Pump**
- **Flushing Cooling System**
- **Auxiliary Hot Water Heater Installation**

Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Drain Plugs	Securely	
Heat Exchanger End Cap		190 (22)
Heat Exchanger Mounting Brackets	Securely	
Hose Clamps	Securely	
Reservoir to Thermostat Housing	30 (41)	
Thermostat Cover	20 (27)	

Lubricants/Sealants

LUBRICANTS/SEALANTS	
92-825407A2	Quicksilver 2-4-C Marine Lubricant
92-34227--1	Quicksilver Perfect Seal

Specifications

CLOSED COOLING SYSTEM CAPACITY
Qts (litres) Approximately
9 (8.5)

THERMOSTAT
143° F (62° C)

PRESSURE CAP
14 PSI (97 kPa)

Description

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate subsystems; the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat (from the closed cooling system) as it passes thru the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck.

IMPORTANT: In the heat exchanger, the coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows thru the inside of the cooling tubes.

Exhaust manifold is seawater cooled. Stern drive seawater pickup, pumps seawater thru the heat exchanger.

Maintaining Coolant Level

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly then, push down and turn cap all-the-way off.

1. Coolant level in; heat exchanger should be within 1" (25mm) from bottom of filler neck.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

2. Coolant level should be between the "Add" and "Full" mark on coolant recovery reservoir with engine at normal operating termperature.

Testing System

Testing Coolant for Alkalinity

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly then, push down and turn cap all-the-way off.

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. If pink litmus paper turns blue, coolant is alkaline and need not be replaced.
4. If pink litmus paper remains pink, coolant is not alkaline and must be replaced.

Pressure Testing System

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

If coolant section of Closed Cooling System is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under "Testing Pressure Cap" in this section, to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.

3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also, check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in fresh water section to 1" (25mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to 17 psi (117 kPa).
6. Observe gauge reading for approximately 2 minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining a pressure of 17 psi on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcock(s), core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Test Heat Exchanger, as outlined.
9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: 1) Loose cylinder head bolts or damaged gasket, 2) cracked or porous cylinder heads. Proceed as follows until location of internal leak is found.
    a. Start engine. Repressureize system to 17 psi and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinder(s), where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.
    b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug, that is perfectly clean or milky appearing, is a sure indication of a leak.
    c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky, if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, repressurize closed cooling section to 17 psi and examine internal surfaces of engine to locate leak.
    d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leaks

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor; and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91cm) long hose for this test.
2. Route this hose so a "U" is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13cm) of the "U".
4. Observe the "U" while the engine is running.
    a. During idle and warm-up: some coolant and/or air will leave the reservoir.
    b. During cruising speed (2500-3500 RPM); coolant and/or air leaving the reservoir should stop after approximately 5 minutes running at a given RPM. A leaking head gasket will produce air bubbling through the "U", going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
    c. At higher speeds (4000 + RPM): Normal operation is the same as described in "b" above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant leaving the reservoir.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately 5 minutes at a given RPM. A head gasket leak will not stop - the one thing that marks a failed head gasket is the continued passage of air, that may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

Testing Heat Exchanger

For Internal Leak: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

a. Remove a seawater hose from the exchanger. Do not drain the exchanger.

b. Pressurize the closed cooling circuit to 14-20 PSI (97-138kPa) with a radiator tester.

c. If seawater begins to flow from the nipple there is a leak.

For Blockage:

IMPORTANT: Seawater flows through the tubes in the exchanger. Closed cooling coolant flows around the tubes.

a. Remove end caps and inspect for any blockage in the seawater circuit.

b. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

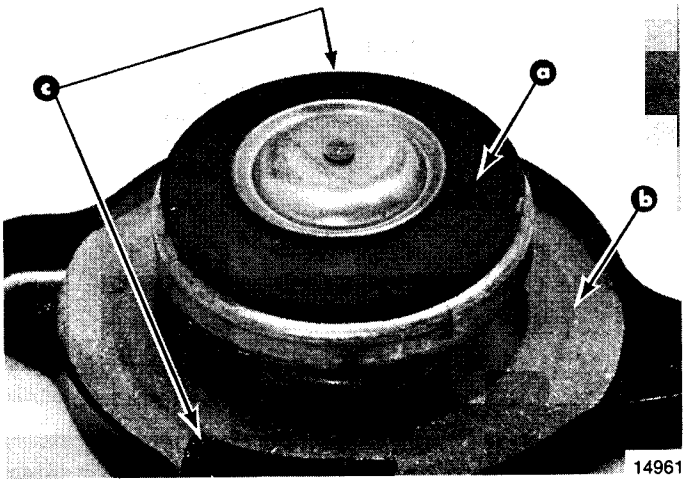
Testing Pressure Cap

Pressure cap is designed to maintain a pressure of approximately 14 psi (97 kPa) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure, as follows;

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

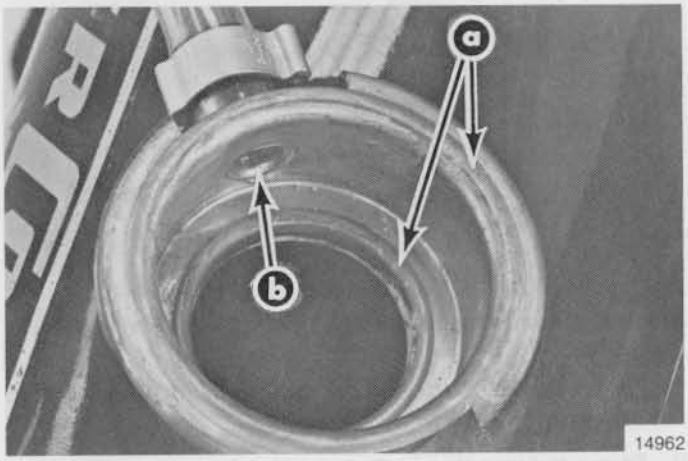
1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap, if rubber seal is damaged.



a - Rubber Seal (Cap Must Be Replaced if Damaged)
b - Gasket (Look for Cracks Under Gasket)
c - Locking Tabs (1 Hidden)

4. Check that locking tabs on cap are not bent or damaged.
5. Using a cooling system pressure tester (similar to one shown.)Test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 14 psi (97 kPa) and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall within these limits.

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



14962

a - Inspect for Damage
b - Clean Coolant Recovery Passage

6. Reinstall cap on reservoir or heat exchanger.

Heat Exchanger Repair

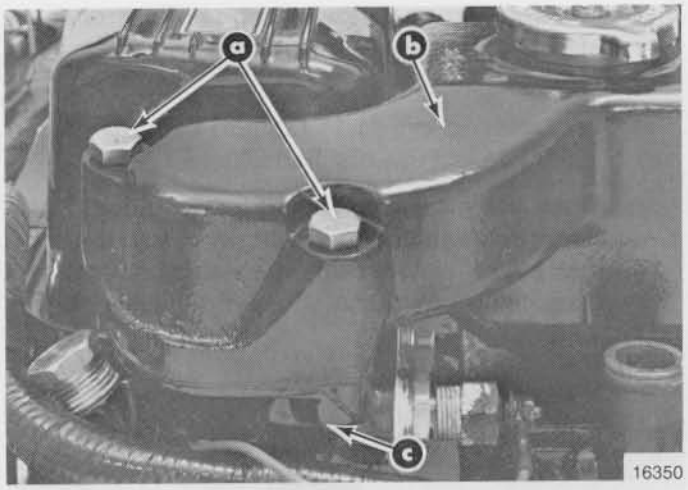
IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than 3 tubes.
2. Nipples and drains, that have been broken off the heat exchanger, can be re-attached by brazing.

Thermostat

Removal

1. Drain coolant from cylinder block and exhaust manifold.
2. Disconnect hose(s) from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing.

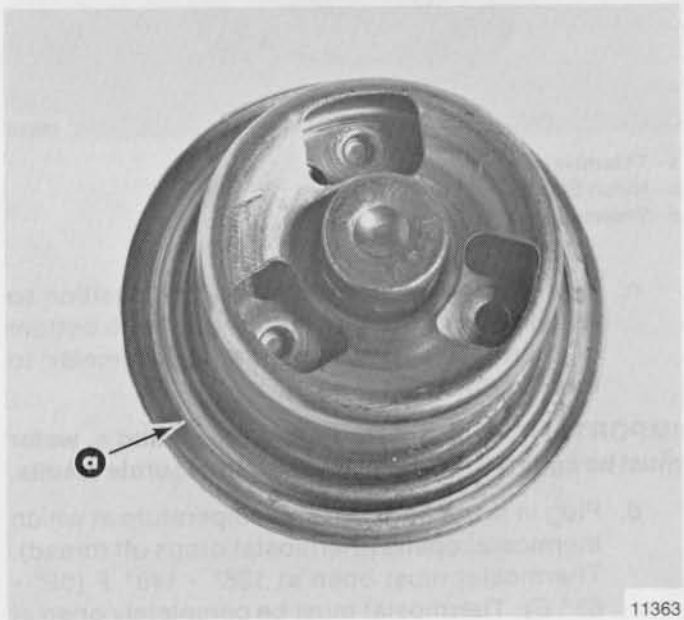


16350

a - Bolts
b - Reservoir
c - Thermostat Housing

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or 2 points around the valve perimeter is acceptable.)



11363

a - Check for Light Leakage around Perimeter of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:

   a. Fill tester to within 1" (25mm) of top with tap water. Do not use distilled water.

   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.

08788

a - Thermometer
b - Nylon String
c - Thermostat

   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

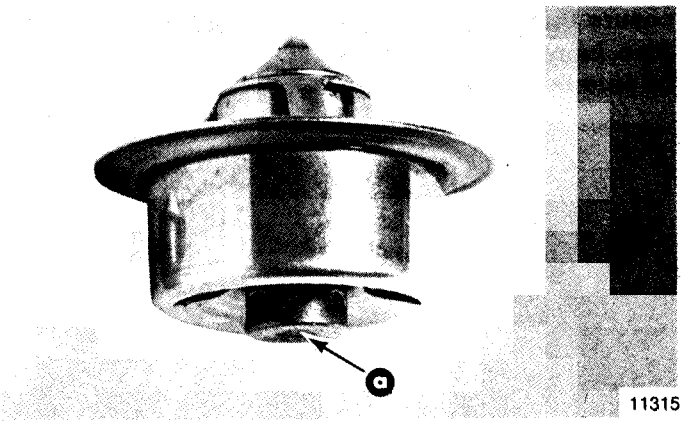
IMPORTANT: When performing Steps d and e, water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at 138° - 145° F (59° - 63° C). Thermostat must be completely open at 170° F (77° C).

   e. Unplug tester and allow water to cool to a temperature 10° F (5° C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

   f. Replace a thermostat that fails to meet all of the preceding tests.

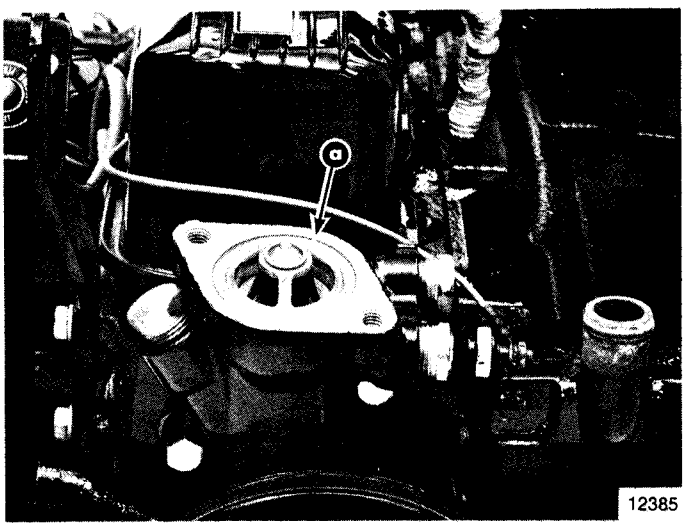
Installation



11315

a - Install Thermostat with This End Toward Thermostat Housing

1. Clean gasket surfaces on reservoir and thermostat housing.
2. Place thermostat in thermostat housing with element end down. Be sure to position thermostat so that mounting flange fits into recess in thermostat housing.



12385

a - Thermostat

3. Coat both sides of new gasket with Perfect Seal and position on thermostat housing. Reinstall reservoir and torque bolts to specifications.
4. Reconnect hose to thermostat cover.
5. Refill closed cooling section as outlined in "Changing Coolant", see Index.

⚠CAUTION

Do not operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged.

6. Start engine and inspect for leaks.

Changing Coolant

Coolant Recommendations

⚠CAUTION

Alcohol or Methanol base anti-freeze or plain water, are not recommended for use in closed cooling section of cooling system at any time.

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol anti-freeze and water. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturers recommendations).

Change Intervals

The old coolant should be drained and flushed from the closed cooling system at least every two (2) years or whenever exhaust gases have entered into the system.

Draining Precautions

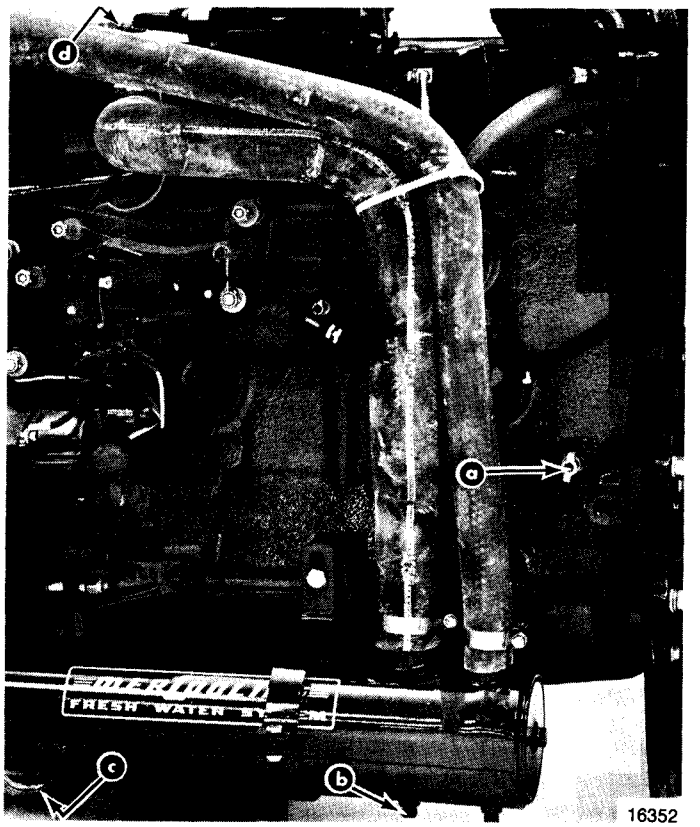
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcocks, removal of petcock may be required so that wire can be inserted completely into drain hole.

NOTE: If possible, place a container under drains to prevent coolant from draining into boat.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove pressure cap from reservoir.
3. Open cylinder block petcock on port (left) side of block.
4. Disconnect heat exchanger to circulating pump hose from front end of heat exchanger and lower to the hose to allow coolant to drain.
5. Remove coolant drain plug from aft end of heat exchanger.



16352

a - Petcock (1)
b - Drain Plug (1) - Coat Threads with Perfect Seal
c - Hose
d - Pressure Cap

6. If so equipped, remove coolant recovery reservoir from mounting bracket and drain coolant.
7. After coolant has drained completely, close cylinder block petcock, install heat exchanger drain plug, and reconnect hose to heat exchanger.
8. Clean system as outlined in "Cleaning System".
9. Fill system as outlined in "Filling Closed Cooling Section".

Cleaning System

Closed Cooling Section

Closed cooling section of Closed Cooling System should be cleaned at least once every 2 years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Manufacturer's instructions, which accompany cleaner, always should be followed.

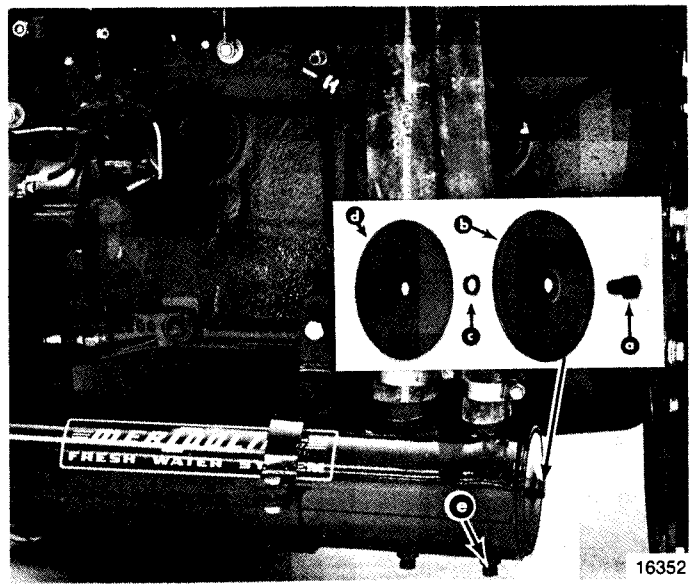
If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

Seawater Section

Cooling efficiency of an engine with Closed Cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every 2 years or whenever decreased cooling efficiency is suspected, as follows:

IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Perfect Seal and reinstall.
2. Remove bolts, which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger.



a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug

3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Apply Perfect Seal to both sides of new end plate gaskets, then reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.) Torque end plate bolts to specifications.
5. Start engine and inspect cooling system for leaks.

Filling Closed Cooling Section

NOTICE
See "Specifications" for appoximate closed cooling system capacity and coolant recommendation.

1. Fill closed cooling section with coolant as follows:
   a. Thru reservior filler neck until coolant solution is 1" (25mm) below filler neck.

⚠CAUTION
Do not operate engine without water flowing thru seawater pickup pumps, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the posibility of air being trapped in the closed cooling section which can cause engine to overheat.

Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.

2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1" below filler neck.
3. After engine has reached normal operating temperature (themostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on heat exchanger.
6. Remove cap from coolant recovery reservoir and fill to "Full" mark with coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat step 4.

IMPORTANT: Engine overheating is often due to air being trapped in fresh water section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING
Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

8. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
9. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

Out-of-Season Storage

Closed Cooling Section

Closed cooling section of Closed Cooling System should be kept filled year around with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol anti-freeze and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

Draining Seawater Section

⚠CAUTION
If the possibility of freezing exists, seawater section must be drained to prevent freeze damage to cooling system and engine. Seawater section also should be drained if boat is to be stored for an extended period of time, to prevent corrosion damage.

⚠CAUTION
If boat is in the water, water inlet valve (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose must be left disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.

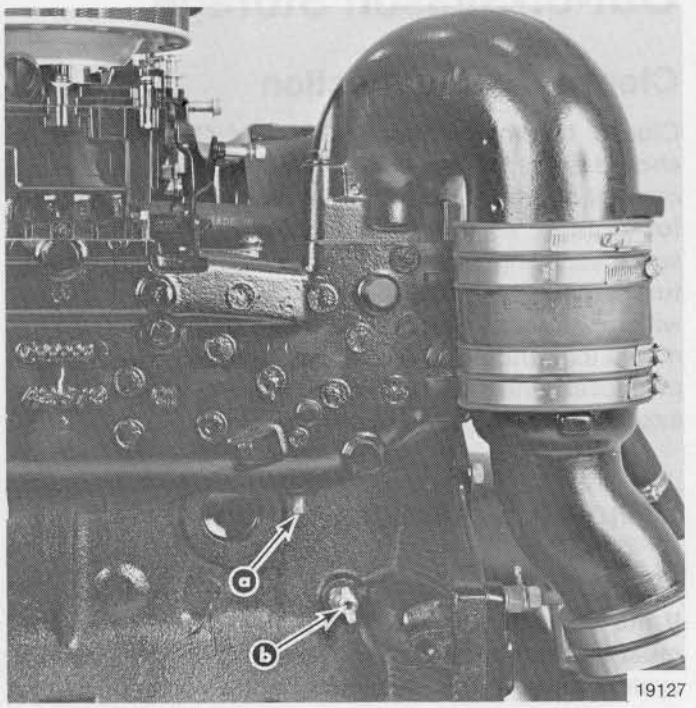
IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.

IMPORTANT: To prevent threads from rusting out during storage, reinstall plugs using Perfect Seal on threads. Never leave drain plugs out during storage.

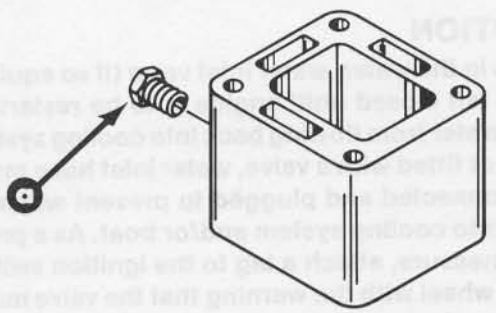
NOTE: If possible, place a container under drains to prevent water from draining into boat.

NOTICE
Refer to "Draining Precautions", in this section, before proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Drain system as shown.

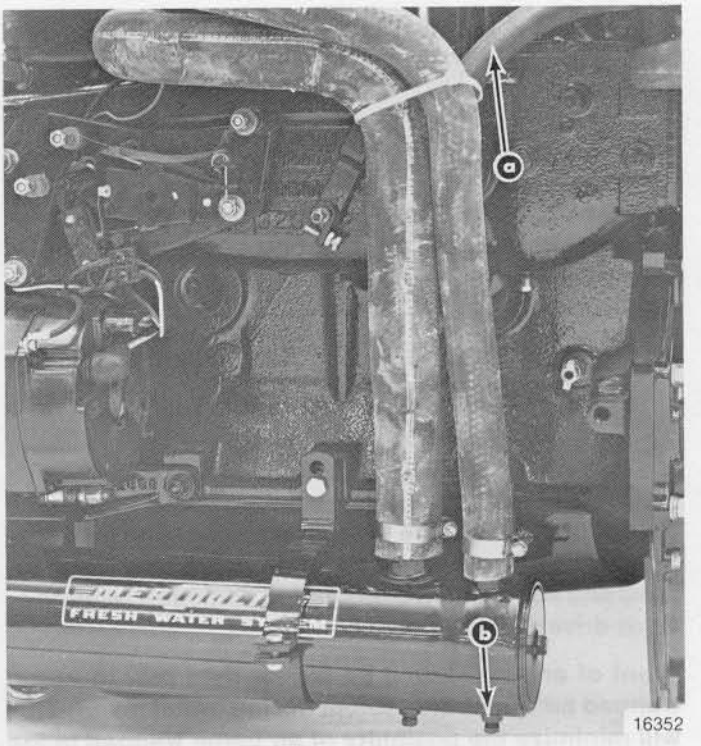


a - Drain Plug
b - Petcock

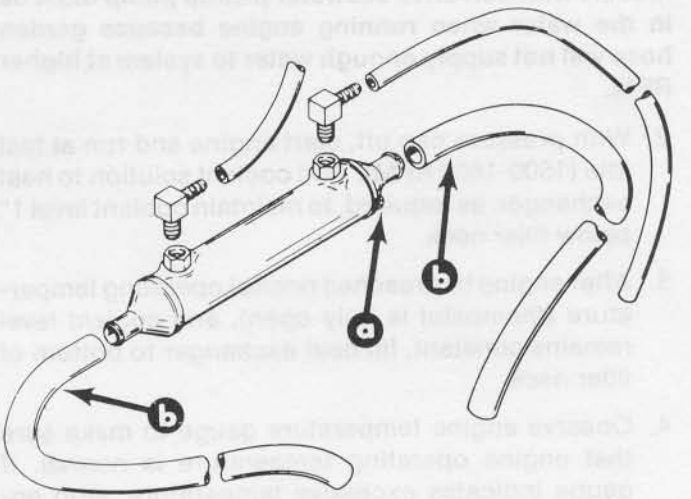


a - Remove Drain Plug

3" or 6" Risers (If Equipped)



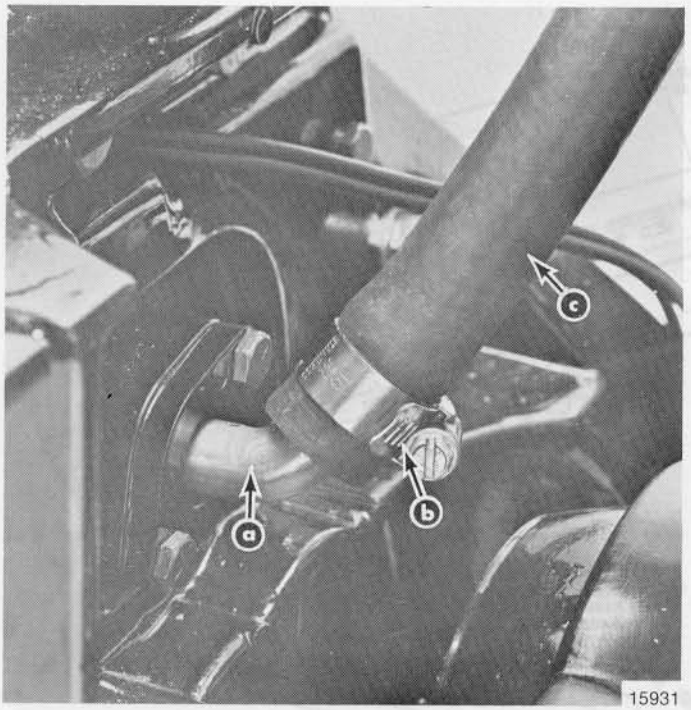
a - Disconnect Seawater Inlet Hose and Lower to Drain
b - Remove Drain Plug (1)



a - Remove Drain Plug
b - Cooler without Drain Plug - Remove Hoses Lower to Drain

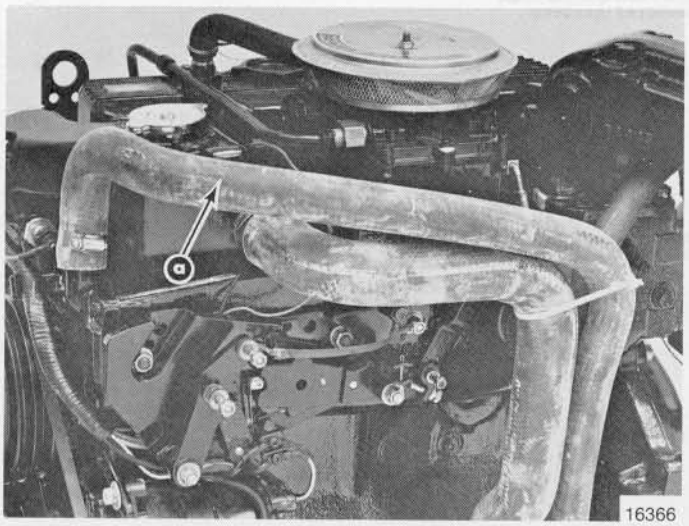
Power Steering Fluid Cooler (If Equipped)

3. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Reconnect hose and tighten clamp securely.
4. **Driveshaft Extension Models:** Disconnect water inlet hose from gimbal housing and lower to drain hose.



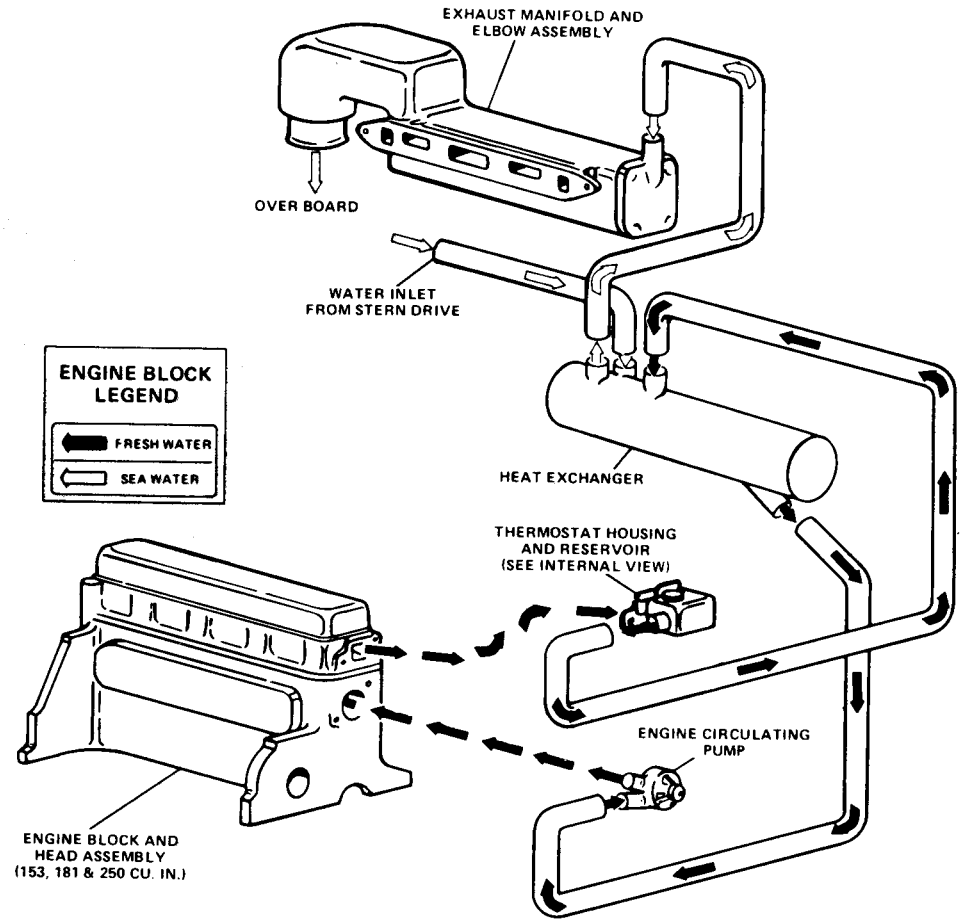
a - Water Tube
b - Hose Clamp (Retighten Securely)
c - Remove Hose, Lower to Drain

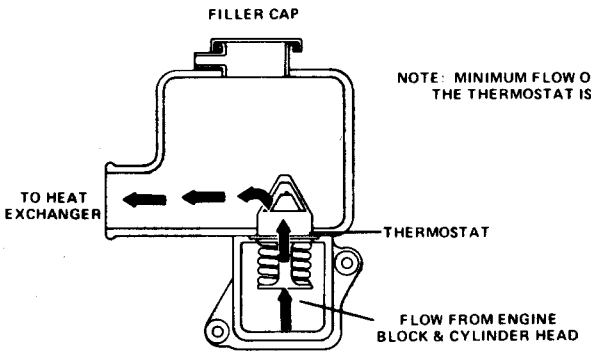
5. For additional assurance against freezing and rust, fill the exhaust manifold and heat exchanger with a solution of permanent anti-freeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed to during storage). To fill manifold and exchanger refer to figure shown.



a - Remove Hose From Manifold End Cap. Pour Coolant into Manifold, Then into Hose until Heat Exchanger if Full. Reconnect Hose. Tighten Clamp Securely

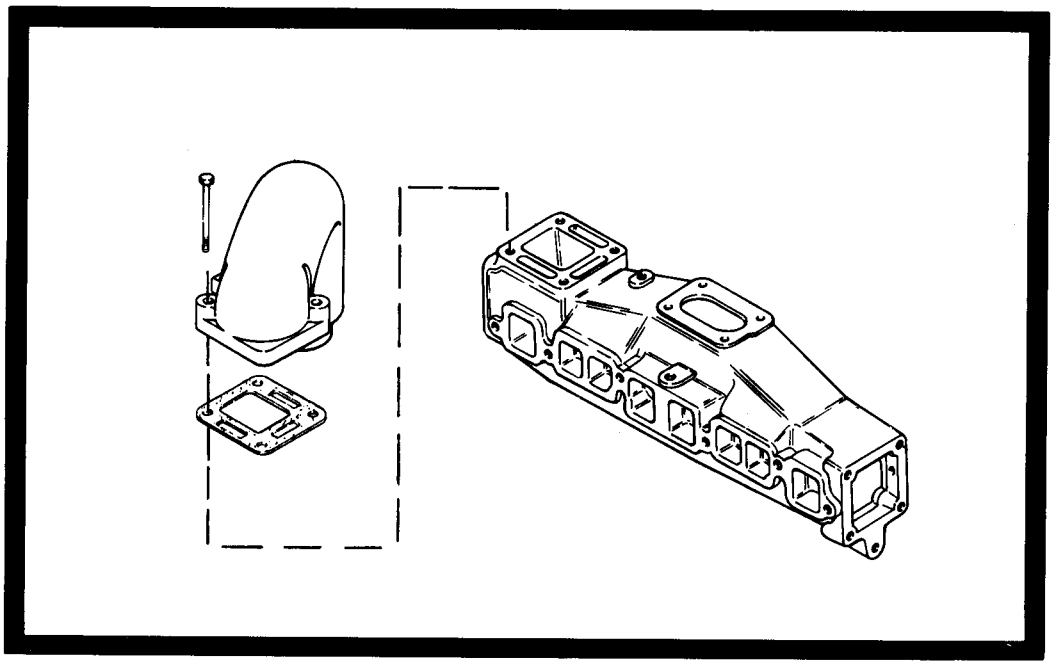
Cooling System Flow Diagrams





COOLANT FLOW THROUGH THERMOSTAT HOUSING AND RESERVOIR

EXHAUST SYSTEM



MCM 120/140/2.5L/3.0L
EXHUAST MANIFOLDS/ELBOWS

6

C

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Upper Exhaust Pipe and Shutter Replacement	6C-4
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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Battery Cables	Securely	
Carburetor	20 (27)	
Hose Clamps	Securely	
End Cap		96 (11)
Exhaust Elbow	25 (34)	
Exhaust Manifold (Note 1)	23 (33)	
Intake Manifold Cover	15 (20)	
Exhaust Riser	25 (34)	
Exhaust Pipe to Gimbal Housing	20-25 (27-34)	
Water Shutter Screw/Nut	Securely	

NOTE 1: Retorque after engine has been brought up to operating temperature.

Sealants

92-32609-1	Quicksilver Loctite
92-34227-1	Quicksilver Perfect Seal
92-86166	Quicksilver Bellows Adhesive

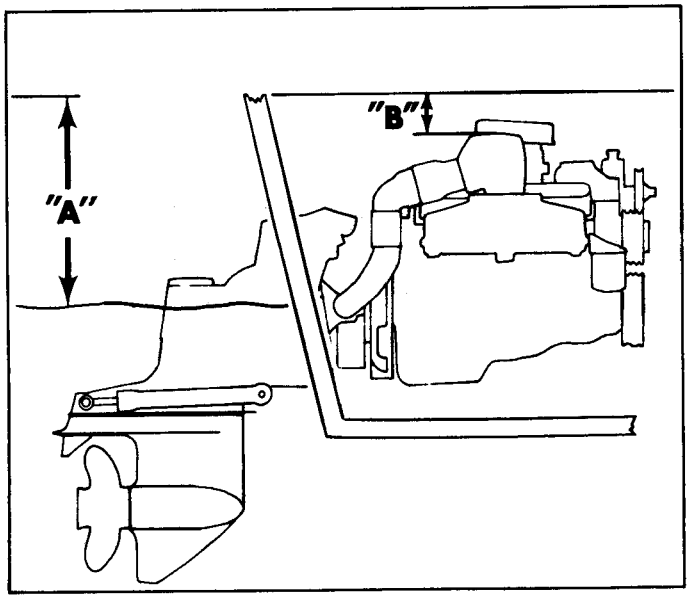
Exhaust System Requirements

Engines with Thru Drive Unit Exhaust

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severly damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective parts(s).

Determine if exhaust elbow risers are required by taking measurements "A" and "B" as shown, with boat at rest in the water and maximum load aboard. Subract "B" from "A". If "A" minus "B" is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



a - From Waterline to Top of Transom
b - From Highest Point on Exhaust Elbow to Top of Transom

Model	"A" Minus "B" Must Be In. (mm) or More
MCM 120/2.5L	11 (279)
MCM 140/3.0L	11 (279)

Removal

1. Disconnect battery cables from battery.
2. Drain water from cylinder block, exhaust manifold and exhaust elbow.
3. Disconnect throttle cable at carburetor.
4. Remove both shift cables from shift plate assembly.
5. Disconnect exhaust hose and cooling hoses.
6. Disconnect fuel line at carburetor.

⚠WARNING

Gasoline is extremely flammable and highly explosive under certain conditions. Be sure electrical source to engine is disconnected. Do not smoke or allow sources of spark or open flame in area when installing new pump. Wipe up any spilled fuel immediately.

7. Disconnect crankcase ventilation hose at rocker arm cover.
8. Remove wiring harness clamps and slave solenoid from manifold.
9. Disconnect engine harness, shift cutout switch wire and wires going to electric choke.
10. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
11. Remove exhaust elbow.
12. Remove exhaust adaptor.

Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Perfect Seal before reinstalling.

IMPORTANT: If manifold to cylinder head studs have broken, install all new studs with Loctite "A" after checking head and manifold surfaces for warpage. Also use all new manifold attaching nuts.

5. Check for cracks.
6. To test manifold body for leaks, block off plates, plugs, or short hoses with plugged ends must be used. One block off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

Installation

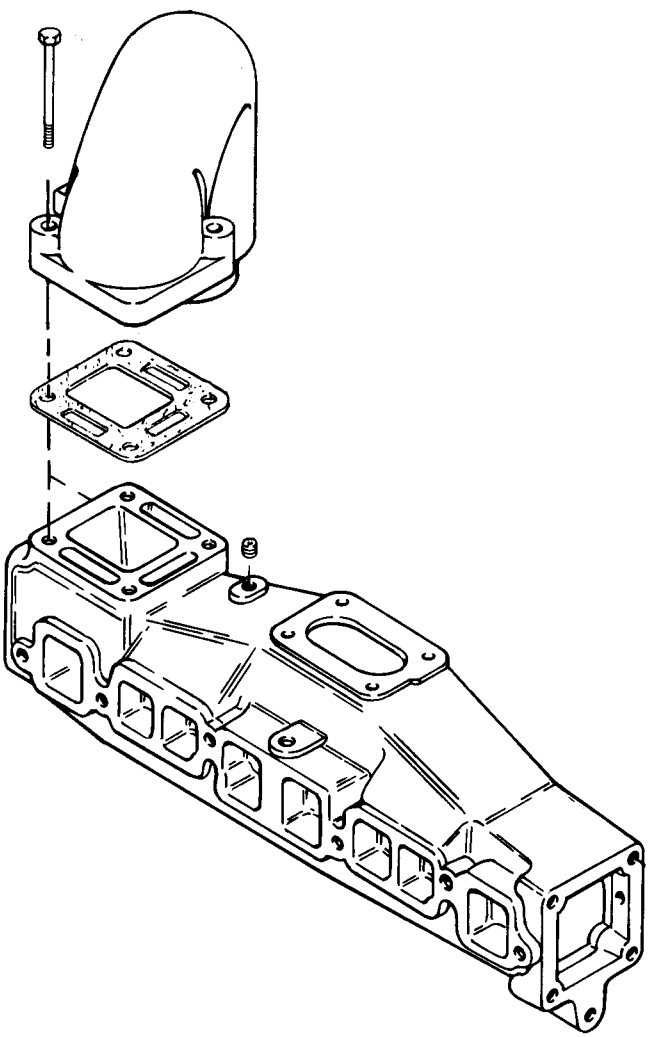
If exhaust manifold body requires replacement, transfer all parts (from old manifold) to new manifold body.

1. Position new gasket on head and install manifold in position, making sure gasket is in place.
2. Tighten fasteners evenly and torque to specifications, starting in center and working out toward ends.

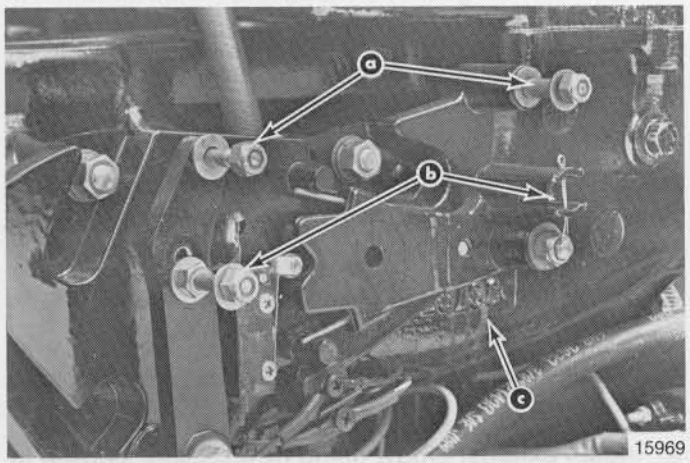
IMPORTANT: After engine has been brought up to operating temperature, allow engine to cool. Retorque manifold fasteners.

3. Install carburetor (if removed) and connect crankcase ventilation hose at rocker arm cover.
4. Install wiring harness clamps and slave solenoid to manifold.
5. Install exhaust elbow using new gasket. Torque to specifications.

IMPORTANT: Install gasket as shown.



6. Connect throttle cable to carburetor. Adjust as outlined in "Removal Installation and Alignment" section.
7. Connect both shift cables as shown.



a - Remote Control Shift Cable Attaching Points
b - Drive Unit Shift Cable Attaching Points
c - Exhaust Manifold

8. Connect engine harness shift cutout switch wires to terminal block.

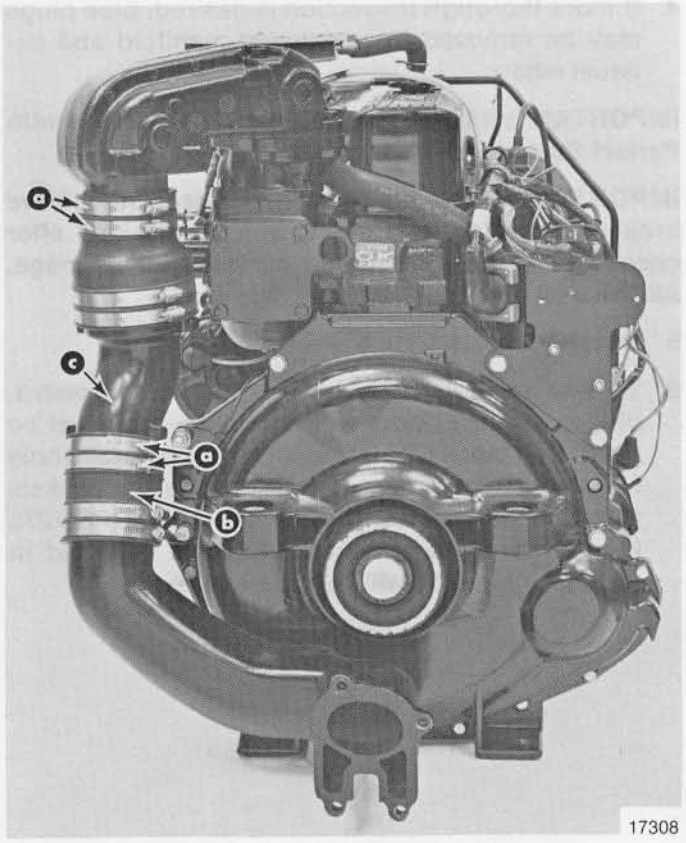
IMPORTANT: Adjust shift cables as outlined in "Stern Drive Service Manual".

9. Connect fuel line and choke tube or electric choke wires.
10. Reinstall exhaust and cooling hoses.
11. Reconnect battery cables to battery. Tighten securely.
12. Start engine, check for exhaust, water and fuel leaks and adjust carburetor idle speed and mixture.

Upper Exhaust Pipe and Shutter Replacement

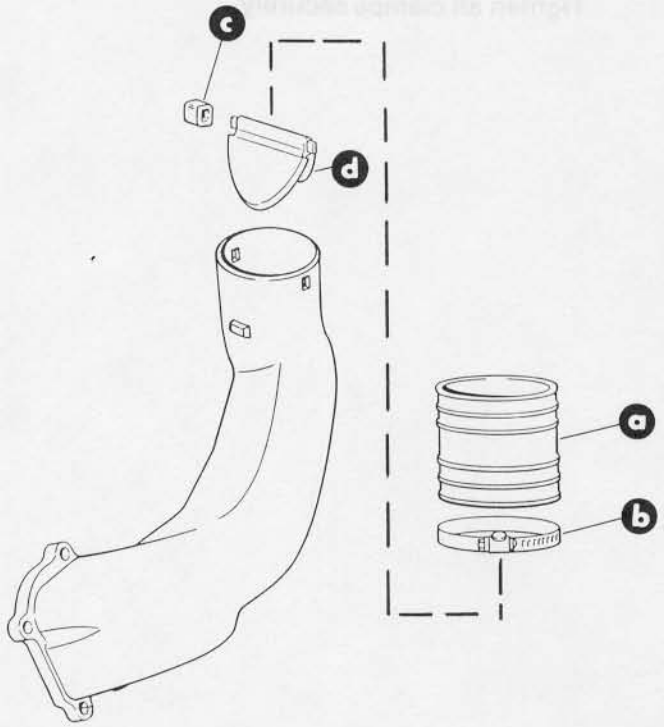
IMPORTANT: Engine does not have to be removed, however, exhaust elbow may have to be removed.

1. Loosen exhaust bellows clamps.
2. Remove hose clamps.
3. Remove upper exhaust pipe.



a - Clamps
b - Connector Hose
c - Upper Exhaust Pipe

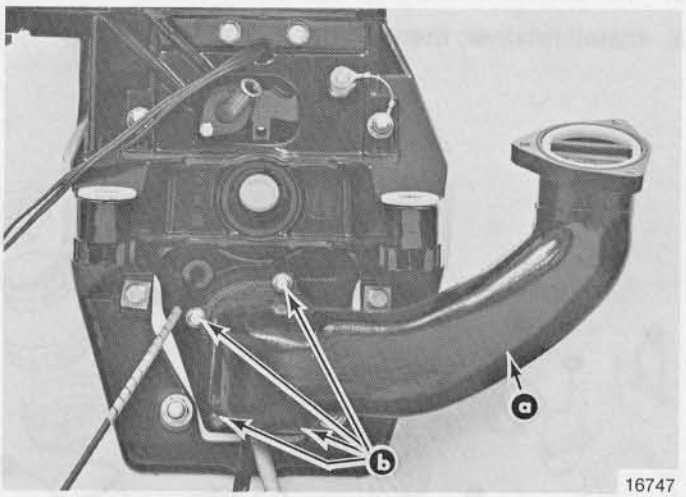
4. Replace shutter (in lower pipe), as shown.
   a. Coat both mating surfaces of hose and lower pipe with Bellows Adhesive. Allow to dry and then slide hose on lower pipe. Tighten clamps securely.
   b. Place clamps over belllows and connector hose, then install upper exhaust pipe.
   c. Making sure all clamps are contacting exhaust elbow, upper pipe and lower pipe, tighten clamps securely.



a - Connector Hose - Remove to Change Shutter
b - Clamps (2)
c - Grommet (2)
d - Shutter - Opens Downward

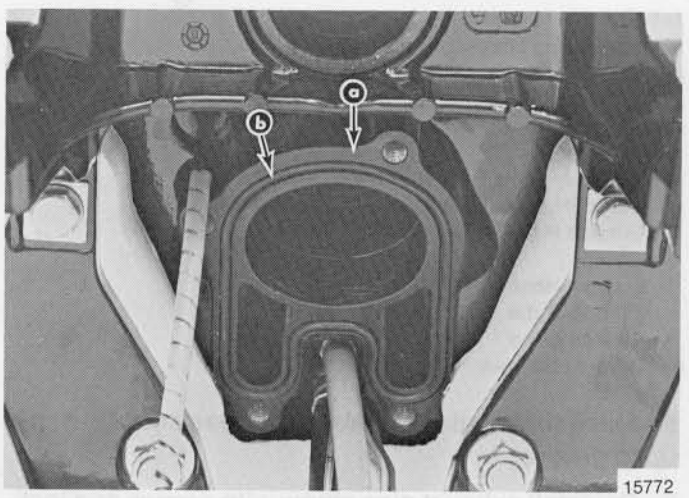
Lower Exhaust Pipe Replacement

1. Remove stern drive unit.
2. Remove engine, then upper exhaust pipe.
3. Remove screws and lockwashers that secure lower exhaust pipe to gimbal housing.



a - Lower Exhaust Pipe
b - Screws and Lockwashers (4)

4. Remove exhaust pipe and "O" ring.
5. Clean mating surfaces on pipe and gimbal housing.
6. Place "O" ring in groove of gimbal housing.



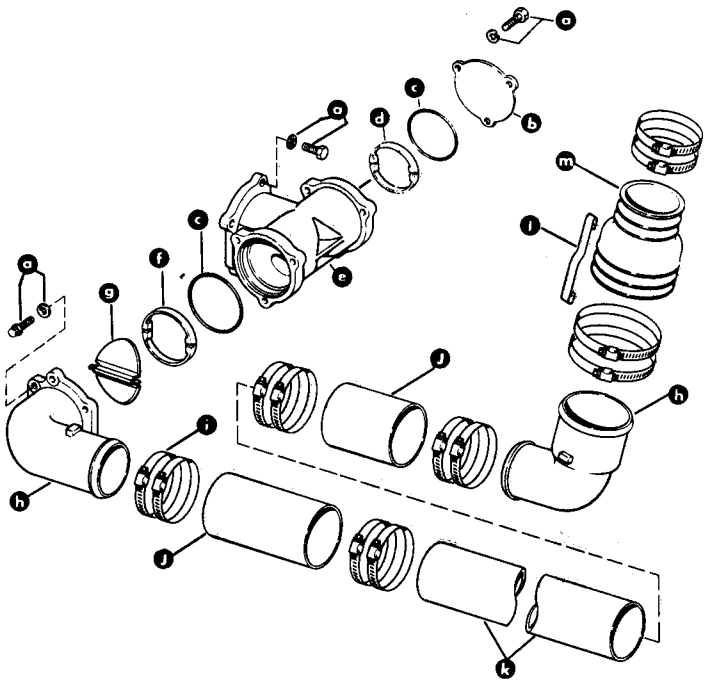
a - Mating Surfaces
b - "O" Ring

7. Reinstall lower exhaust pipe with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
8. Reinstall upper exhaust pipe, then engine.
9. Reinstall stern drive unit.

Driveshaft Extension Models

Shutter Replacement

1. Loosen hose clamps on exhaust hose and remove screws and lockwashers.
2. Remove exhaust pipe elbow.
3. Remove water shutter, then retainer from tee pipe.
4. Install retainer, then shutter as shown.



a - Screws and Lockwashers
b - Plate
c - "O" Ring
d - Retainer - Slots Toward Inside of Tee Pipe
e - Tee Pipe
f - Retainer - Slots Facing Toward Outside of Tee Pipe
g - Water Shutter - Opens Toward Inside of Tee Pipe
h - Exhaust Pipe Elbow
i - Clamps
j - Exhaust Hose
k - Exhaust Tube
l - Ground Strap
m - Exhaust Bellows

5. Make sure mating surfaces are clean and "O" ring is in groove.
6. Reinstall exhaust pipe elbow with screws and lockwashers, torquing them to specifications. Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.
7. Tighten clamps securely.

Exhaust System Component Replacement

1. To replace any component in system as shown. The following must be adhered to:

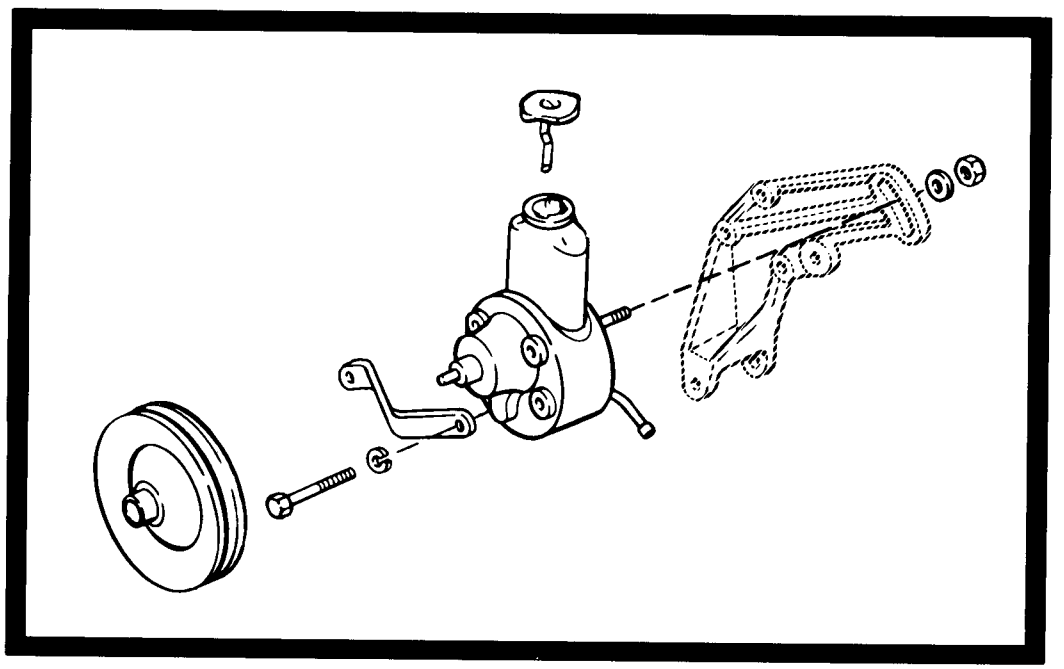
   All mating joint surfaces must be clean.

   "O" rings must remain in groove to properly seal joints to prevent leakage.

   Torque all screws and lockwashers to specifications.

   Tighten all clamps securely.

POWER STEERING



mercruiser
STERN DRIVES & INBOARDS

A 7

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Torque Specifications

Fastener Location	Lbs. Ft. (N.m)	Lbs. In. (N.m)
Crankshaft Pulley to Harmonic Balancer	20 (27)	
Harmonic Balancer to Crankshaft	60 (81)	
Pump Mounting Bracket to Engine	30 (41)	
Recirculation Pump Pulley		240 (27)

Tools/Sealants/Fluids

MERCURY MARINE SPECIAL TOOLS	
91-93656A1	Pulley Installer

KENT-MOORE SPECIAL TOOLS	
Can be ordered from: Kent Moore Tools, Inc. 29784 Little Mack Roseville, MI. 48066 Phone: (313) 774-9500	
J-25034	Pulley Removal Tool

SEALANTS/FLUIDS	
92-34227-1	Quicksilver Perfect Seal
92-90100A12	Quicksilver Power Trim and Steering Fluid
	Automatic Transmission Fluid (ATF) Dexron or Dexron II

Precautions

⚠WARNING
Always disconnect battery cables from battery BEFORE working on engine to prevent fire or explosion.

⚠CAUTION
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

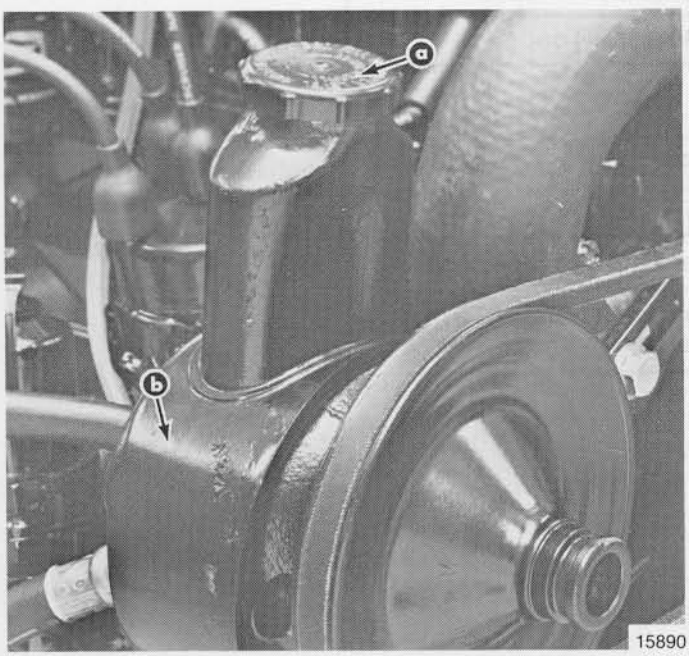
⚠CAUTION
DO NOT pry on Power Steering pump when adjusting belt tension. Serious damage may result.

Checking Power Steering Pump Fluid Level

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

WITH ENGINE COLD

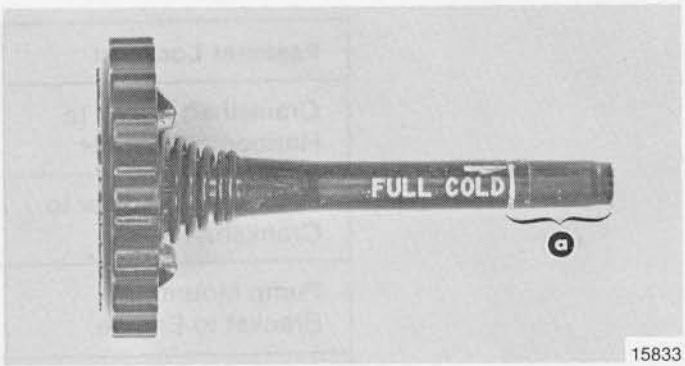
1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.



15890

a - Fill Cap
b - Power Steering Pump

3. Level should be between "FULL COLD" mark and bottom of dipstick.



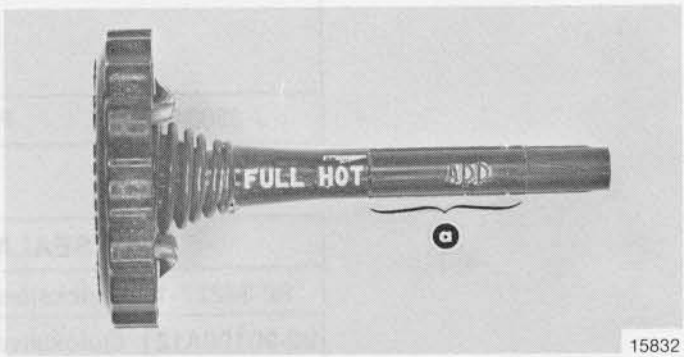
15833

a - Proper Fluid Level with Engine Cold

4. If fluid level is low but, still visible in pump reservoir, add fluid thru fill cap opening to bring level up to "FULL COLD" mark on dipstick. Do not overfill.

WITH ENGINE WARM FROM OPERATION

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from Power Steering pump and note fluid level.
3. Level should be between the 'FULL HOT" mark and "ADD" mark on dipstick.



15832

a - Proper Fluid Level with Engine Warm

4. If level is low (below "ADD" mark), but still visible in pump reservoir, add fluid thru fill cap opening to bring level up to "FULL HOT" mark on dipstick. Do not overfill.

Filling and Air Bleeding Power Steering System

IMPORTANT: Power Steering system must be filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back. Remove shipping cap from Power Steering pump and check fluid level with dipstick attached to fill cap (provided). Add fluid as required, to bring level up to correct level.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in Power Steering System.

2. Turn steering wheel back-and-forth to end of travel in each direction several times; then, recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse; then, check fluid level and add fluid, as required, to bring level up to "Full-Hot" mark on dipstick. Do not overfill. Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and Power Steering fluid must be hot to accurately check fluid level.

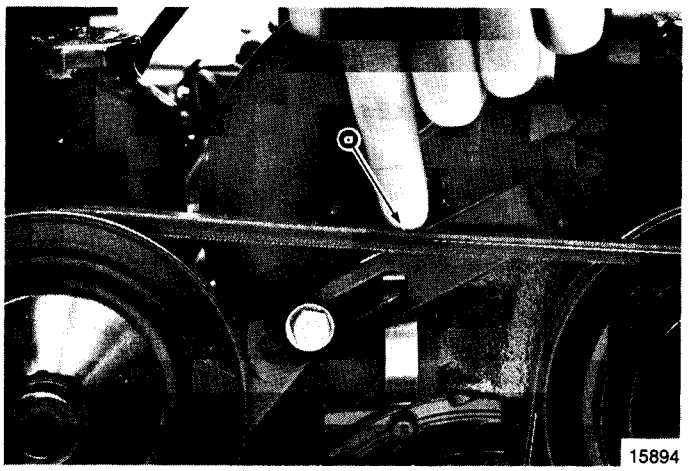
6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Pump Drive Belt Tension Adjustment

IMPORTANT: Refer to Precautions in this section before proceeding.

IMPORTANT: Do not pry on pump body.

1. Install drive belt on pulleys and adjust tension as follows:
2. Pivot pump to attain tension.
3. Tighten retaining bolts.



a - Check Belt Tension Here

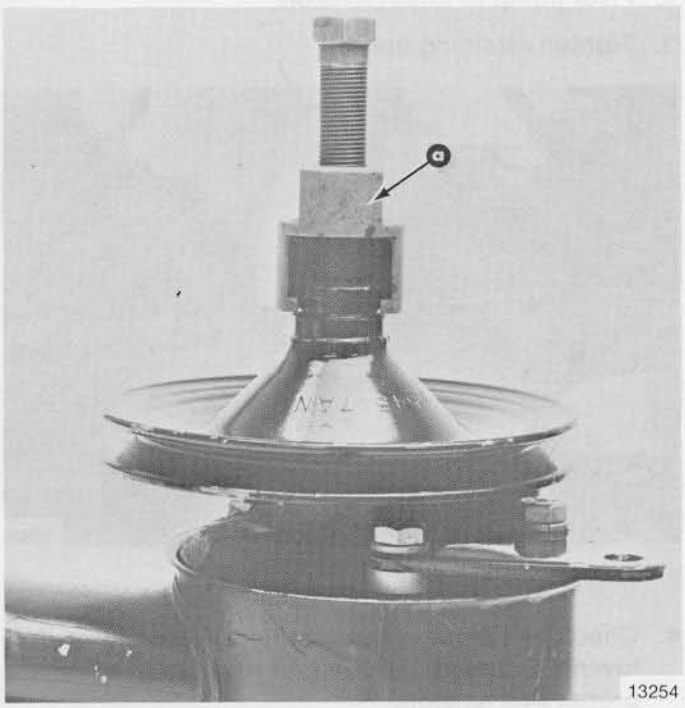
4. Check belt tension using either of 2 methods, following and readjust pump, if necessary, to obtain proper belt tension.
   a. Using a strand tension gauge, take gauge reading at mid-point of Power Steering pump belt. Gauge should read 75-95 lbs. (334-423 N.m).
   b. Check belt tension by pushing down on upper strand of belt at belt mid-point. Belt should depress 1/4 in. (6 mm).

Important Service Information

Pump Pulley Replacement

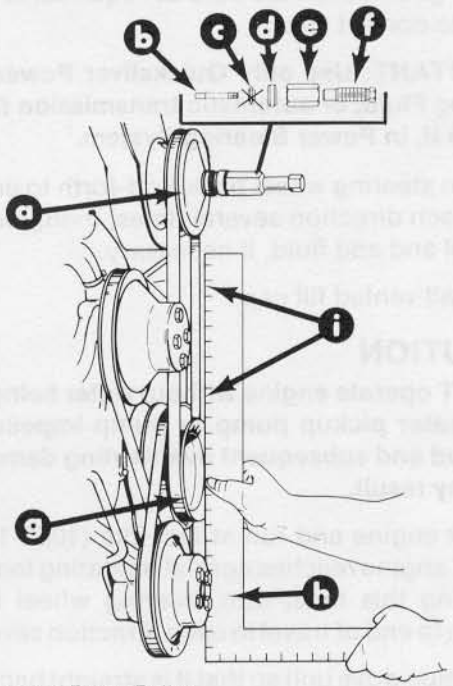
1. Use Kent Moore Tool (P/N J-25034) to remove pump pulley.

IMPORTANT: Do not use Kent Moore Tool (P/N J-21239) to remove these pulleys. This tool has a tapered end and will damage the shaft.



a - Kent Moore Pulley Removal Tool J-25034

2. Install pulley, as follows, using Pulley Pusher Assembly 91-93656A1, and a long straight edge:
   a. Place pulley on pump shaft.
   b. Thread stud ALL-THE-WAY into pump shaft. Place bearing over stud. DO NOT use spacer from kit.
   c. Thread nut onto shaft. Thread shaft (and nut) ALL-THE-WAY onto stud.
   d. Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
   e. Check pulley installation for correct alignment.



a - Power Steering Pump Pulley
b - Stud
c - DO NOT Use Spacer
d - Bearing
e - Nut
f - Shaft
g - Crankshaft Pulley (Shown) or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

Power Steering System Testing and Repair

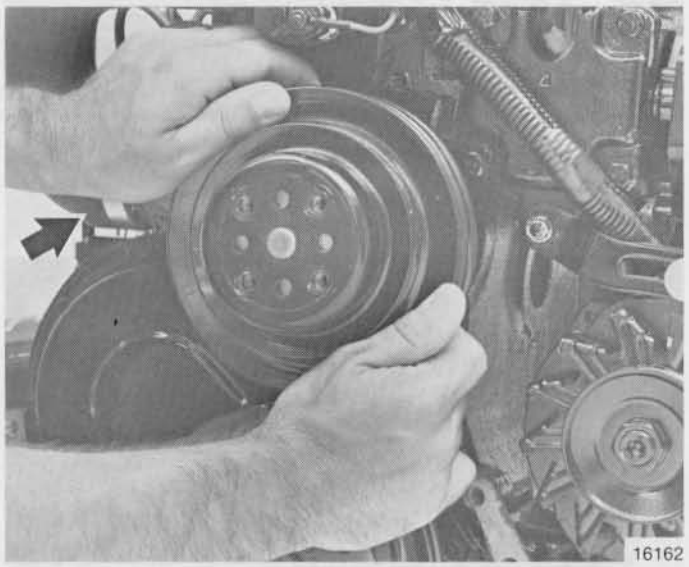
Refer to appropriate MerCruiser stern drive service manual.

Power Steering Pump and Cooler

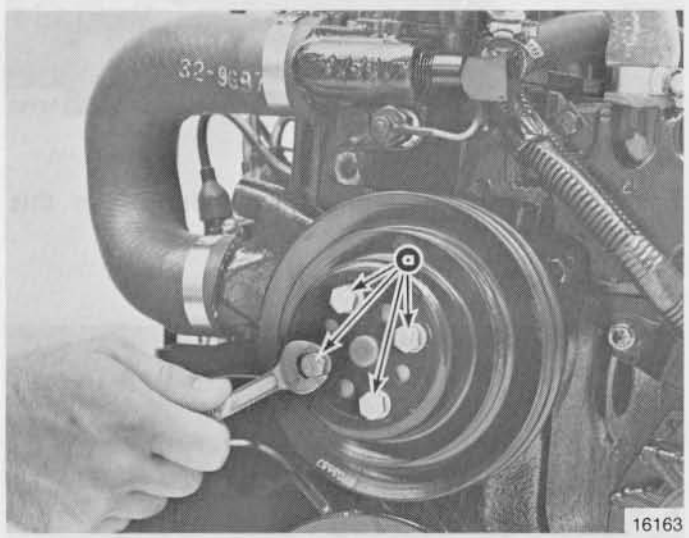
Replacement

IMPORTANT: Refer to "Precautions", in this section BEFORE proceding.

1. Install pulley.

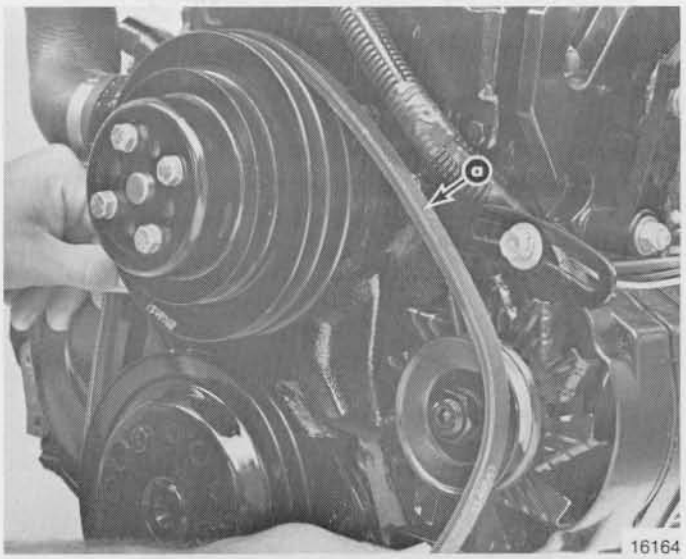

16162

2. Install bolts and torque to 240 lbs. in. (27 N.m).


16163

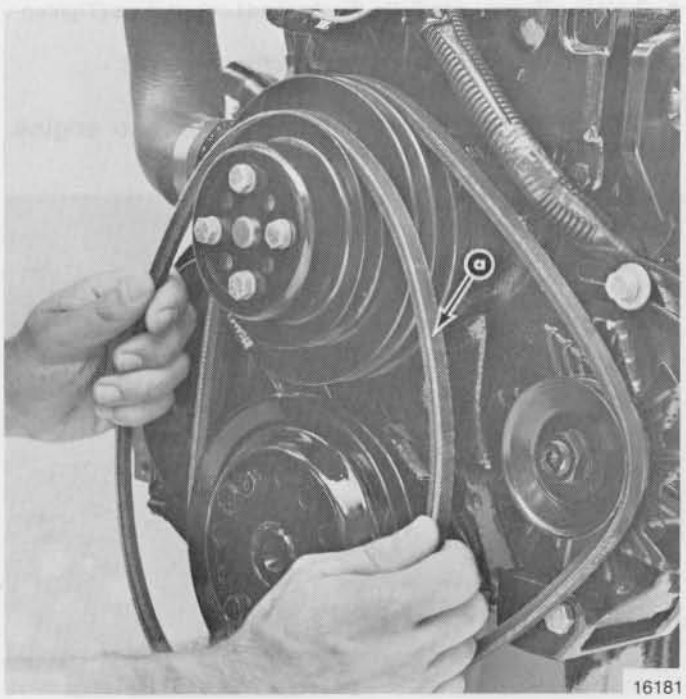
a - Bolts and Lockwashers

3. Install 40 in. (101.6cm) drive belt.


16164

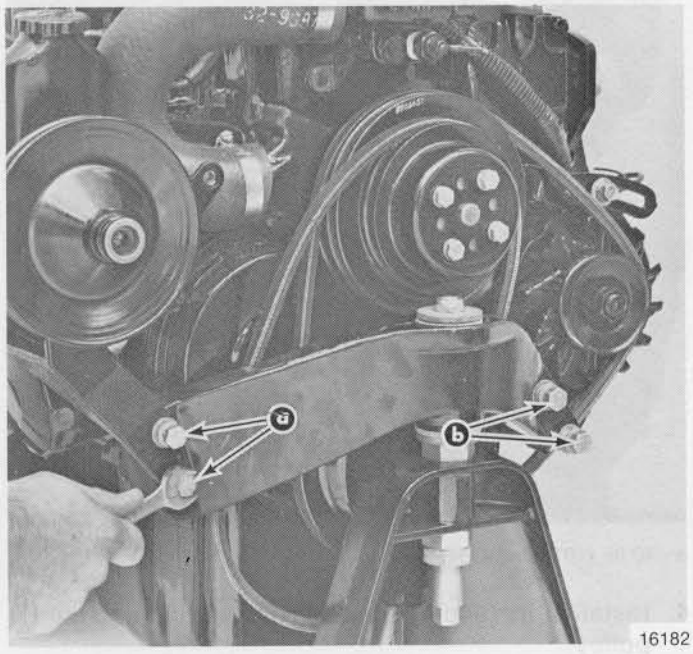
a - 40 in. (101.6cm) Drive Belt

4. Install 37 in. (94cm) drive belt over circulating pump pulley.


16181

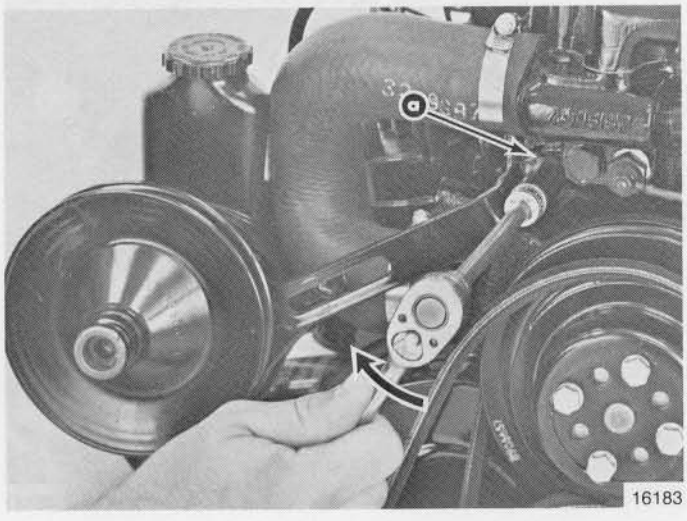
a - 37 In. (94cm) Drive Belt

5. Install front mount assembly with Power Steering pump assembly. Tighten bolts securely.



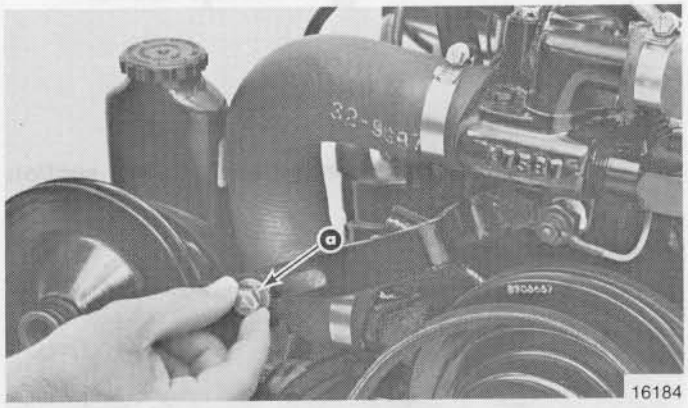
a - 2-3/4 In. (70mm) Long Bolts, Washer and Lockwashers (Tighten Securely)
b - Bolts, Washers and Lockwashers (Tighten Securely)

6. Attach Power Steering pump bracket to engine. Torque bolt to 30 lbs. ft. (41 N.m).



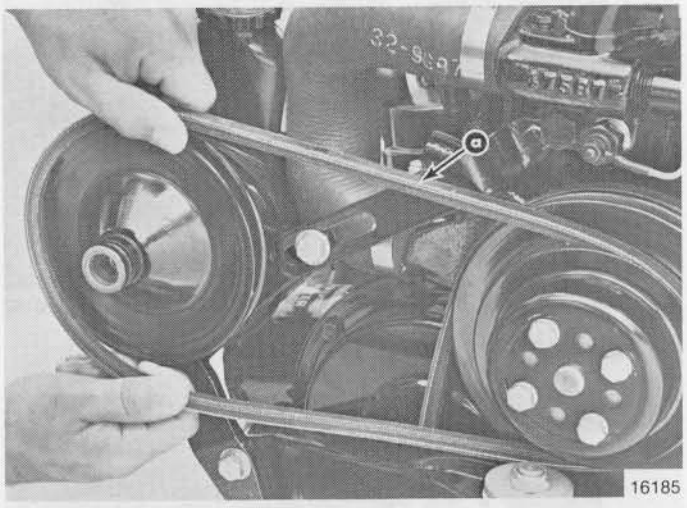
a - 1-1/4 In. (32mm) Long Bolt Without Closed Cooling. 1-1/2 In. (38mm) Long Bolt With Closed Cooling

7. Attach Power Steering pump brace to pump.



a - 7/8 In. (22mm) Long Bolt and Washer

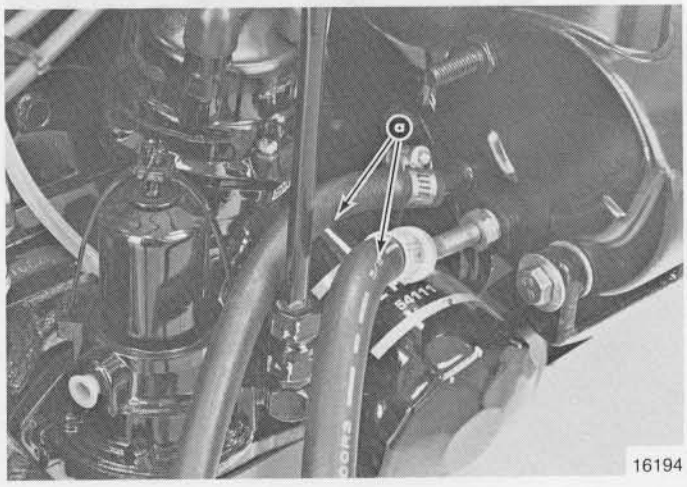
8. Install 37 in. (94cm) drive belt over pump pulley.



a - 37" (94cm) Drive Belt

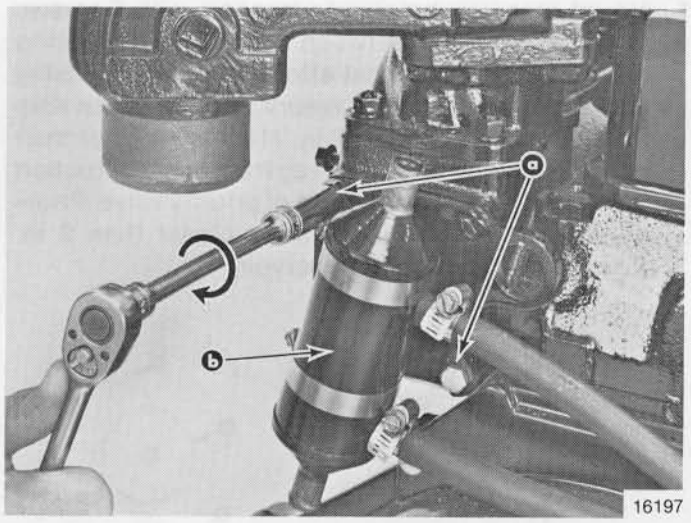
9. Adjust drive belt tension (see "Index" in this section).

10. Route hydraulic hoses as shown.



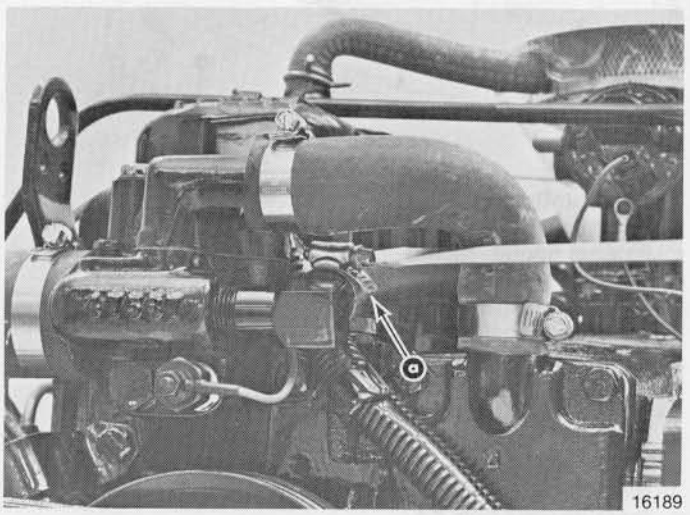
a - Hydraulic Hose Routing

11. Install fluid cooler and tighten screws securely.

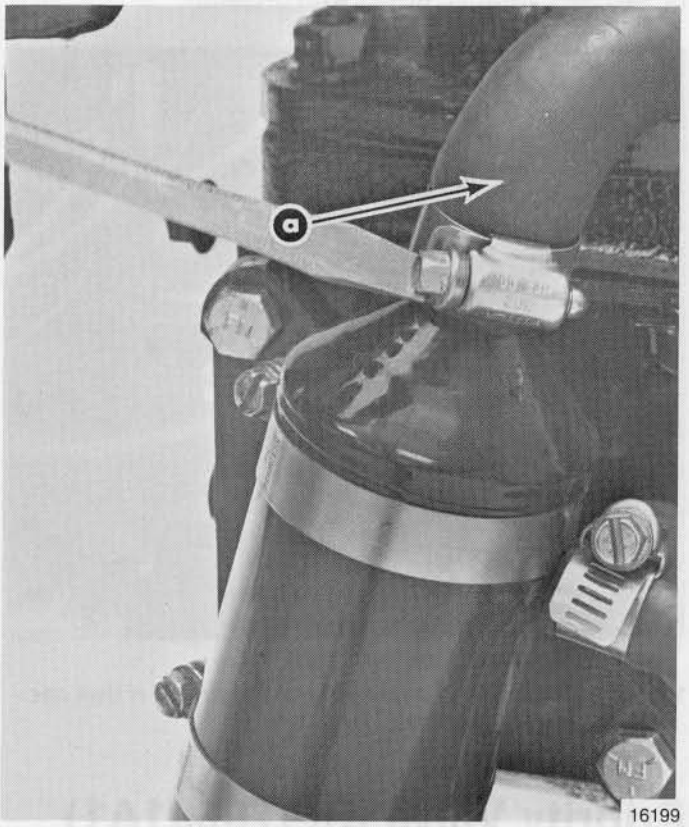


a - Install 1" (25mm) Long Bolts. Tighten Securely
b - Fluid Cooler

12. Install long water hose and tighten clamps securely.

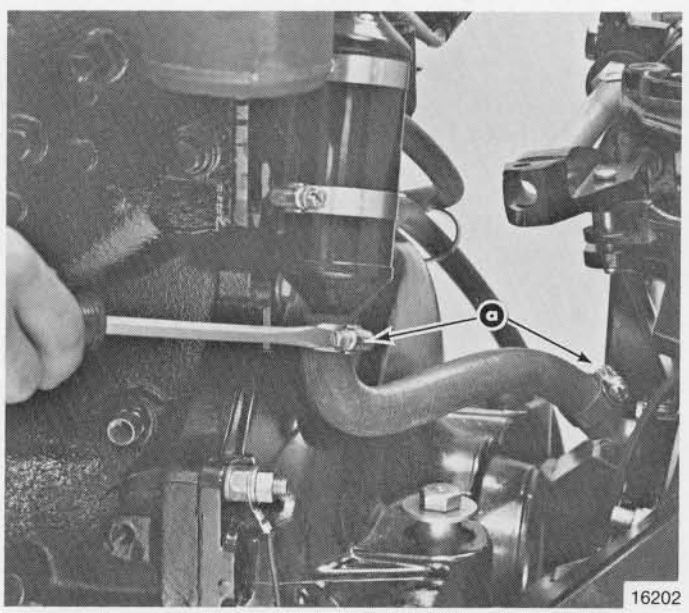


a - Installing Engine End of 24 In. (61cm) Water Hose



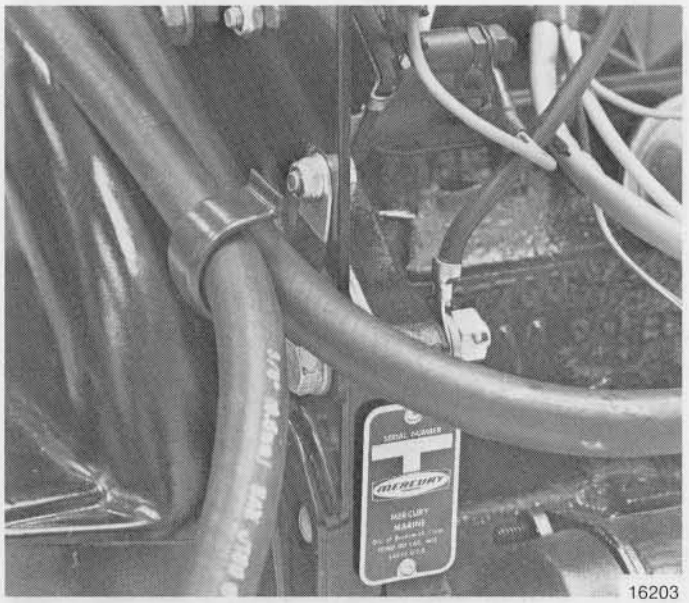
a - Installing Cooler End of 24 In. (61cm) Water Hose

13. Install short water hose and tighten clamps securely.



a - Install Short Hose

14. Secure hydraulic hoses with J-clamp.



16203

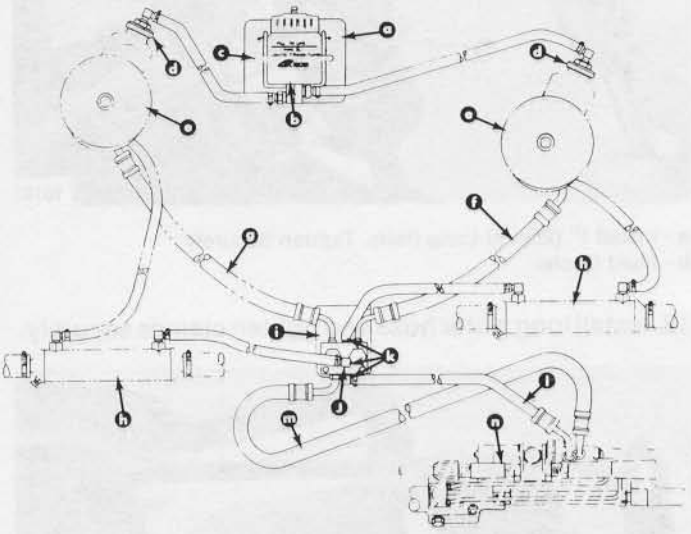
15. Fill and air bleed system, as explained in this section (see "Index").

Priority Valve Kit (79691A1)

IMPORTANT: This kit is for use on Dual Installations where both engines are equipped with Power Steering pumps, Coolers, related hardware and hoses and one Transom assembly is equipped with Power Steering.

Installing Reservoir

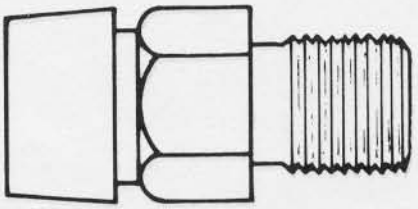
1. Mount reservoir bracket to transom with 2 screws (from kit) halfway between the 2 Power Steering pumps in a location that affords both accessibility and visual inspection of reservoir oil level. Be sure that location is at ieast 6 in. (150mm) higher than pumps and is far enough away from any obstruction that might prevent mounting of priority valve. Priority valve must be mounted no closer than 2 in. (51mm) from bottom of reservoir.



a - Reservoir Bracket
b - Bottle Reservoir
c - Retainer Spring
d - Cap Assemblies
e - Power Steering Pumps
f - Secondary Pressure Line
g - Primary Pressure Line
h - Coolers
i - Priority Valve Bracket
j - Priority Valve
k - 90° Elbows
l - Return Hose from Kit
m - Pressure Hose from Kit
n - Power Steering Control Valve

2. Position bottle reservoir in mounting bracket and secure with retainer spring from kit.

IMPORTANT: The two-way check valve is required for cold weather operation below 40° F (4° C). Remove vent from reservoir cover and replace with two-way check valve, if conditions require. (It is not necessary to replace vent if temperature is above 40° F [4° C], unless reservoir overflows during operation.)



Two-Way Check Valve

3. From bulk hose (supplied with kit; hose without fittings), cut 2 hoses of sufficient length to extend from bottom of reservoir to fill caps on pumps. Allow enough extra hose for routing and installation of cap assemblies.
4. Secure hoses with sta-straps to keep them below reservoir and away from excessive engine heat and moving parts.
5. Position hose clamps over ends of hoses, connect one end of each hose to reservoir and other end of each hose to a cap assembly. Tighten hose clamps securely. DO NOT fasten caps to pumps at this time.

Installing Priority Valve

1. Install valve mounting bracket with 5/16-9 x 2 in. (51mm) lag bolts and washers (from kit) in a central position under reservoir. Be sure that location will allow 2 in. (51mm) or more between priority valve and reservoir when priority valve is mounted to bracket.
2. Install 90° elbows (from kit) into priority valve (at locations marked "T"), using location of coolers, and Power Steering control valve as guides for direction of elbows. Use liquid pipe joint sealer to seal connections and tighten fittings securely.
3. Secure priority valve to bracket with 5/16-18 x 2-3/4 in hex head bolts, nuts and washers from kit. Tighten securely.
4. From bulk hose (supplied with kit; hose without fitting), cut 2 hoses of sufficient length to extend from Power Steering cooler to respective fitting on priority valve.
5. Position hose clamps over ends of hoses and connect one end of each hose to its respective Power Steering cooler and the other end to fitting on priority valve. Use sta-straps to keep hoses away from excessive engine heat and moving parts.
6. Install hose (fitting on one end only, from kit) to Power Steering control valve. Route hose to priority valve, then cut hose to length, position hose clamp over end and install hose to its respective fitting.
7. Install hose (with fittings on both ends, from kit) between Power Steering control valve and "S" (large) position on priority valve.
8. Install both pressure hoses (leading from pumps) to "S" (small) locations on priority valve, as shown.